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THE WATER CONSUMPTION of Greater New York for the year 1900 appears to have averaged about 115 gallons per capita for the 3,437,000 inhabitants shown by the national census taken in June of the same year. Manhattan and the Bronx, or old New York, used about 133 gallons, and Brooklyn borough some 85 gallons. The exact figures for the whole city are not available, since the annual report of Mr. Wm. Dalton, Commissioner of Water Supply, does not give any returns for the dozen or so small plants in various parts of the city owned by private water companies. Figures collected by the late Mr. Lebbens B. Ward for the Merchants' Association report on the "Water Supply of the City of New York" showed that these companies supplied about 22,000,000 gallons a day in 1899, of which some 4,000,000 gallons was furnished by the Long Island Water Supply Co., the plant of which is now owned by the city. As most of the companies have limited supplies and a few million gallons one way or the other has little effect on the per capita consumption of the whole city, the supply furnished by private companies in 1900 may be assumed as 18,000,000 gallons. Mr. Dalton reports an aggregate of 377,000,000 gallons a day from the various municipal plants, thus making a total of 395,000,000 gallons for the whole city. This is divided as follows: Croton, 255,375,000; Bronx and Byram, 18,220,000; Ridgewood (Brooklyn), 86,964,000; Gravesend, New Utrecht and New Lots, 8,642,000 (also Brooklyn); Queens borough, 7,697,000; Richmond borough, 89,000 (a very small plant at Tottenville, Staten Island); twelve private companies, mostly in Queens and Richmond, 18,000,000 gallons. The Croton and the Bronx and Byram supplies combined amounted to 273,595,000 gallons in 1900, and were consumed in and formed practically the total supply of the boroughs of Manhattan and the Bronx, or the old city of New York. The population of these boroughs in June, 1900, was 2,050,600, thus giving an average daily per capita consumption of 133 gallons, as already stated. The four municipal plants in the borough of Brooklyn supplied 95,606,000 gallons a day. The three private companies in the same borough delivered an average of about 2,400,000 gallons a day in 1899, according to Mr. Ward. The population of Brooklyn borough in June, 1900, was 1,167,000, so the consumption per capita, from public and private works, could not have been far from 85 gallons a day.

A LARGE PUMPING ENGINE CONTRACT at Cincinnati, O., has been awarded to the Holly Manufacturing Co., of Lockport, N. Y. It includes three 25,000,000 and three 12,000,000-gallon self-contained vertical triple expansion engines and an electric crane. The large engines will pump water to the Eden Park reservoir and will cost $410,500. The small ones will pump to the Eden Park high-service tower and will cost $391,900. The price of the crane is $11,000. It is said that a large part of the work will be done at Cincinnati by the Laidlaw-Dunn-Gordon Co.

BIDS FOR THE BALANCE OF THE 300,000,000-gallon Weston aqueduct for the supply of Boston and vicinity will be received late in August or early in September. These bids will cover some 3½ miles of aqueduct. The general character and scope of the work was stated in our issue of Feb. 7, 1901. Mr. F. P. Stearns, M. Am. Soc. C. E., is Chief Engineer of the Metropolitan Water and Sewerage Board.

SEPTIC TANKS AT MADISON, WIS., have been put in operation as a substitute for the chemical precipitation plant shut down some months ago. Prof. F. E. Turneaure, Assoc. Am. Soc. C. E., is city engineer.

A CONTINUANCE OF SEWAGE DISPOSAL by dilution has been recommended by Mr. C. H. Rust, M. Am. Soc. C. E., City Engineer of Toronto. He advises an intercepting sewer discharging into Lake Ontario three miles beyond the easterly city limits, which would be about nine miles from the water-works intake. If this plan is not approved by the city council, he recommends the construction of septic tanks and filter beds. Mr. Rust visited England some months ago for the purpose of studying the sewage disposal problem.

A COMBINED GRANITE AND WOOD PAVEMENT was laid as an experiment at Leicester, England, a few years ago. It consisted of alternate rows, at right angles to the length of the street, of granite blocks 3 ins. in width and Australian hard wood blocks 1 in. wide and 9 ins. long, the fibers being vertical. In other words, 3 ins. of stone alternate with 1 in. of wood. The object of this combination was to secure the durability of granite without its attendant noise. It is said that very satisfactory results attended its use. The pavement was laid at street intersections, and, on repaving the streets with wood the combination pavement has given place to wood alone. The character of the joints and the relative wear of the wood and the stone is not stated in the London "Contract Journal," from which the foregoing is taken. Mr. E. G. Mawbey is Borough Surveyor of Leicester.

MORE WOODEN BLOCK PAVEMENT is being laid in Boston, evidently, like the first, as an experiment. The section now under construction is located on Beacon St., west of Massachusetts Ave. A 6-in. concrete base, made with Rosendale cement, is being used. The foregoing is based on a note in the July bulletin of the Boston Society of Civil Engineers, which continues the description of the work as follows: "The blocks are of long-leaf yellow pine 4 ins. deep, 4 ins. wide, and 8 ins. long. The blocks are treated as follows: Heated to 215° F. for one hour, in an air-tight cylinder, for the purpose of getting rid of moisture; then heat is increased and pressure applied gradually for two hours, until 285° and 90 lbs. pressure are reached, both of which are maintained for an hour; heat is then shut off and tanks allowed to cool for an hour, until heat is reduced to 250°, and pressure to 40 lbs.; pressure is then further reduced and a vacuum of 26 ins. is applied; while under vacuum, the Creo-resinate mixture is run into the cylinder at a temperature of 175° to 200°, and a hydraulic pressure of 200 lbs. per sq. in. is applied until 22 lbs. of the mixture per cu. ft. has been absorbed; the liquid is then run off, and the wood is treated for an hour with milk of lime, at a temperature of 150°, and under 200 lbs. pressure. The blocks are laid on a 1-in. cushion of clean-screened sand, and driven as tightly together as possible at every sixth row. The joints are filled with dry-screened sand, and the pavement rolled with a 5-ton steam roller. The joints are then run full of Creo-resinate mixture heated to 300° F. The surface of the paving when completed is to be covered with ¼-in. of clean-screened, sharp sand or crushed-stone screenings."

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head-end collision between two local freight trains on the Missouri, Kansas & Texas R. R. near Wymark, Indian Territory, on July 15. The collision occurred on a bridge near a sharp curve. The engines came together in the middle of the bridge, which collapsed. Five men were killed and two seriously injured. The accident was due to a misunderstanding of orders.

THE NEW YORK CIVIL SERVICE COMMISSION announces the following examinations: August 6, Superintendent of dam construction; July 29 and 31, two assistant bacteriologists, at $900 and $1,200 per year. Address Lee Phillips, Secretary, No. 346 Broadway, New York.

THE TRANS-BAIKAL RAILWAY is now completed to Stretensk, on the Amur River, and the "train de luxe," leaving Moscow every Wednesday at 8.35 p. m., lands its passengers at Stretensk in 11 days, including the 9 hours by transfer steamer across Lake Baikal. The first-class fare for this trip is $58.14. From Stretensk to Kharbarovsk the traveler uses the Amur River steamers, the trip consuming a week and the fare being $21.79; from the latter point to Vladivostock the trip is made on the Ussurian Railway in 32 hours, at a cost of $8.49. The time between Moscow and Vladivostock is thus reduced to 19 days, at a cost of $88.42 for first-class travel. The steamer trip from Odessa to Vladivostock consumes six weeks, and costs $257.50 in gold.

THE TRANSCONTINENTAL RAILWAY, connecting Chili and Argentina, may be completed with American capital, says the U. S. Bureau of Statistics. The completion of this line may bring about a revival of interest in the Pan-American railway project. According to the report of the Intercontinental Railway Commission, the entire distance—by the proposed railway—between New York and Buenos Ayres is 10,228 miles, of which 4,772 miles were constructed in 1898. The estimated cost of building the remaining 5,456 miles was $175,000,000. Of the mileage then constructed, 2,094 miles were in the United States, 1,183 miles in Mexico, and 936 miles in Argentina; of the lines to be built, 1,354 miles would be in Colombia, 658 in Ecuador, 1,633 in Peru, and 392 in Bolivia.

THE REID-NEWFOUNDLAND MONOPOLY ended on July 19 by the signing of a new contract between the government and Mr. W. G. Reid. The government repays to Reid his purchase money, or $1,200,000, with interest, and again takes possession of its railways, telegraphs, public lands, etc. The government has made new contracts with Reid for operating several services. Reid proposes to raise $5,000,000 by a limited liability company, to be used in developing the resources of the colony, and he is to deposit $2,500,000 of this sum as a guarantee. He retains the ownership of the St. John's graving dock, and has a 30-year contract for operating the eight coasting steamers.

SEVENTY PRESSED STEEL CARS FOR SPAIN were shipped last week by the Pressed Steel Car Co., of Pittsburg, Pa. These cars are intended for use on the Great Southern of Spain Railway, and they will be landed at Aquiles, a port in Southern Spain. The 70 cars were shipped in parts and carefully boxed, 32 cars being required to take the lot from Pittsburg to New York. Each car has a capacity of 80,000 lbs., and when set up in Spain by an engineer sent out by the manufacturers they will be 26 ft. 6⅝ ins. long, 8 ft. wide and 9 ft. 9½ ins. high from top of rail to top of body. The light weight is 29,180 lbs., giving them a ratio of 75.09% of paying load to total weight of loaded car. The gage of the Spanish railway is 5 ft. 6 ins. The order for these cars came through the Transportation Development Co., of London, the foreign agents of the Pressed Steel Car Co., and this same London company has also recently secured an order of 450 pressed steel cars for the government railways of New South Wales.

GUASTAVINO ARCHES were recently tested by the New York Building Department. Three different arches were tested, all of 3 ft. width, built in the usual way of 1-in. hard-burned tile laid in Portland cement with broken joints and then concreted level. The load was applied by piling pig iron over the entire area of the arches. A 6-ft. span, with two courses of tile, or 2½ ins. thick, sustained a load of 45,000 lbs., or 2,500 lbs. per sq. ft., with a maximum deflection of 0.13-in. A 12-ft. span, with three courses of tile, or 3¾ ins. thick, carried a load of 112,500 lbs., or 3,125 lbs. per sq. ft., with a maximum deflection of 0.32-in. A 10-ft. span, with four courses of tile, or 5 ins. thick, carried 111,150 lbs., or 3,705 lbs. per sq. ft., with a maximum deflection of 0.19-in. No cracks or signs of failure appeared under any of the above tests. As the New York Building Department demands a factor of safety of 10, the above arches have been accepted for a safe load to that extent.

THE WEIGHT OF ELECTRICAL MACHINERY in proportion to its output is discussed in a paper recently read before the Electrotechnical Society of Vienna by Herr Seefehlner. His data, which he has collected from 18 different manufacturers, is summarized in the following table of weights in pounds per K.-W.:

Capacity.	5 K-W.	10 K-W.	20 K-W.	100 K-W.
Induction motor	19.5	16.8	15	14.1
Transformer	21.2	16.3	13.6	12.7
D. C. motor.....	31.9	25.	23.3	18.2
Tri-phase generator		34.	26.2	19.1

The figures show that up to a certain size the weight of material per unit of power decreases rapidly with increasing capacity, but for higher capacities the weight per unit of power is very nearly constant. At the present prices of electrical machinery in the United States its cost may be taken roughly at about $1 per lb.

THE RUSSIAN CRUISER "NOVIK," built at the Schichau Shipyard, in Germany, has an average speed of 25 knots, making her the fastest vessel of her type afloat. The "Novik" is 374 ft. long, 40 ft. beam and 3,000 tons displacement. The protective deck is 2 ins. thick, and she will be armed with quick-firing guns and torpedo tubes. Russia is favoring the building of many other vessels of this type, and has several more under construction.

AN INTERNATIONAL EXHIBITION of Modern Decorative Arts will be held in Turin, Italy, from April to November, 1902. It is the first exhibition of the kind, and will especially cover the modern house and its decorative elements; the modern room in its decorative whole, and the house and street decoration combined. The president of the American Committee is Mr. L. P. di Cesnola, of New York, to whom all queries should be addressed.

THE U. S. 16-IN. BREECH-LOADING RIFLE.

From a report submitted by Col. J. P. Farley, Ordnance Department U. S. A., and printed in the "Journal of the United States Artillery" for May-June, 1901, the following points are noted in connection with this remarkable weapon of war.

This 16-in. B. L. rifle is a type gun the first of a series intended for sea-coast defense. While guns of larger caliber have been constructed—such as the 17.76-in. Italian gun, the 16.5-in. French gun and the 16.25-in. Armstrong gun for battleships, none of these compare in energy and range with this new 16-in. American gun. With smokeless powder this latter gun requires a charge of 576 lbs.; and with a maximum powder pressure of between 37,000 and 38,000 lbs. to the sq. in., it is estimated that this gun will throw a 2,370-lb. projectile, with a muzzle velocity of 2,300 ft. per second, and a muzzle energy of 88,000 ft. tons. By using a slower-burning powder, it is believed that a greater energy and velocity can be developed. In comparison with this estimate, the Italian gun imparted to a 2,000-lb. projectile a muzzle velocity of 1,700 ft. per second, and a muzzle energy of only 40,000 ft. tons. The French gun used a 1,700-lb. projectile, with a muzzle velocity of 1,700 ft. per second and a muzzle energy of 36,000 ft. tons. The English projectile weighed 1,800 lbs., and the velocity was 2,100 ft. per second, and the energy 51,000 ft. tons at the muzzle. Expressed in percentages, with the American gun representing 100, the maximum energy of the Italian gun was 45%, that of the French gun 41%, and the English gun 65%.

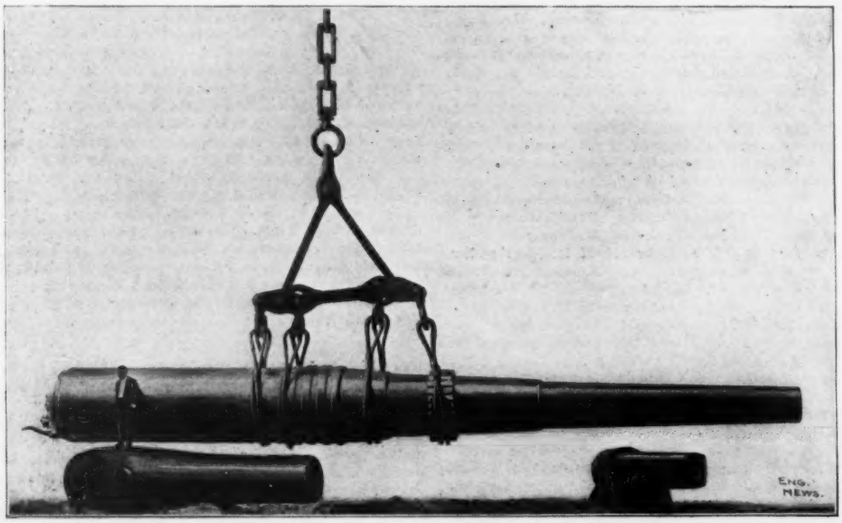
The projectile for the American gun will be 5 ft. 4 ins. long; and it would penetrate, at the muzzle, 42.3 ins. of steel, by De Marre's formula. The range is estimated at about 21 miles; and in making this range the shell would reach a maximum elevation of 30,516 ft., or nearly 5.8 miles.

The total length of this gun is 49 ft. 2.9 ins., with a rear diameter of 60 ins., gradually diminishing to 28 ins. at the muzzle. The length of the main bore is 37 ft. 4.5 ins., with a diameter of 16 ins. The cylindrical part of the powder-chamber is 90.7 ins. long and 18.9 ins. diameter; and this connects with the main bore by a conical slope 24 ins. long. The main bore is rifled, with 96 lands and 96 grooves, the latter 0.06-in. deep; the twist is increasing on a semi-cubic parabola, starting with one turn in 50 calibers, and gradually increasing to one turn in 25 calibers at the muzzle. The breech recess, containing the threaded and slotted parts for the locking of the breech-block, is 24.4 ins. long, and has a diameter of 24.86 ins. at the top of the threads.

This 16-in. gun is built up as follows: The tube, 566.5 ins. long, with a maximum outside diameter of 29.3 ins. Two C-hoops are shrunk over the tube from the forward end of the jacket to the muzzle. The jacket is 304.65 ins. long, and is shrunk on the rear portion of the tube from the end of the C-hoop; this jacket overhangs the rear end of the tube for 24.4 ins. and forms the breech recess. The D-hoop is 144.5 ins. long, and is shrunk over the forward end of the jacket and rear part of the C-hoop. Its bore contains two locking shoulders, which grip over two corresponding shoulders on the jacket and C-hoop, and thus prevent the sliding backward of the jacket, or forward of the C-hoops. Three A-hoops are next shrunk on; the A^1 overlaps the rear part of the D-hoop with its front end, and the outer surface of the jacket with its rear end; hoops A^2 and A^3 are shrunk directly over the jacket. The B-hoops will be shrunk outside of the A-hoops, and their form depends on the style of mount finally adopted—a detail not yet fully determined. For the same reason the full weight of the finished gun cannot be given, though this can be estimated from some of the finished weights of parts, as follows: Tube with C-hoops, 100,260 lbs.; jacket, 73,900 lbs.; D-hoop, 23,900 lbs.; three A-hoops, 49,970. The total finished weights of these parts are—248,030 lbs. The probable finished weight will be 358,400 lbs. The modified estimate of 1891 calls for a completed gun weighing 130 tons, from forgings which in the rough were to weigh 375 tons.

The special tools for making this gun were contracted for in 1894, and three boring and turning lathes, designed at the Watervliet Arsenal, were made by the Pond Machine Tool Co., of Plainfield, New Jersey. These lathes were 138 ft. long, with a swing of 9 ft., and each lathe weighed 280 tons. To facilitate transportation the bed of the lathe was built in six separate sections. The 12-in. gun-lathe was used for a turning-lathe, and the rifling-machine was extended in length and fitted for the 16-in. gun. A 150-ton traveling crane was made for this work by the Morgan Engineering Co., of Alliance, O. Instructions for manufacturing this 16-in. type gun were dated Jan. 26, 1897, and the first forging for this gun was received at the Arsenal on Feb. 19, 1898. In all eleven especial machines and tools were purchased or refitted for making these 16-in. guns, the majority of them being made by the Pond Machine Tool Co.

The photograph of this 16-in. gun shown herewith was made from the original model for this gun; and it will be changed in the matter of the trunnion hoops to adapt it to the Buffington disappearing gun-carriage.



20-Inch Rodman Smoothbore, Weight 116,000 Lbs.; Projectile Round Shot, 1,000 Lbs.

16-inch B. L. Rifle; Weight 358,400 Lbs.; Projectile, 2,370 Lbs.

300-Pounder 10-Inch Parrott Rifle, Weight 26,000 Lbs.; Projectile, 300 Lbs.

THE BIG GUNS OF THE PRESENT AND OF A HALF CENTURY AGO.

EARTH ROADS AND EARTH WORK.*

By Halbert Powers Gillette.†

The cheapest in first cost and consequently the most common form of road is one made entirely of earth, properly crowned and rolled, either by wheels, or by rollers; and in any case, whatever may be the paving material, the cross section should be designed along the lines now to be described, if true economy in construction is desired.

PROFILE OF CROSS SECTION OF ROAD.—It is too prevalent a practice to design a uniform cross section for a road, regardless of the soil of which it is made; regardless of the climatic conditions, and the drainage area that the ditches must serve; regardless of the location or slope of ditches, and regardless of side-hill or other excavation. As an introduction to the consideration of these factors present practice in road construction will be discussed, as exemplified by the standard cross section used and recommended by the Massachusetts Highway Commission.

The ditches are commonly made 3 ft. deep, 1 ft. wide at the bottom, with side slopes of .2 to 1, as shown by Fig. 1.‡

This great depth is given to the ditches, we are told, for the purpose of thoroughly draining the soil under the road, so that frost will not heave or destroy the road surface, a theory that the writer has not found to be sustained by experience. Even granting that a shallower ditch would leave more moisture under the road that would freeze, it becomes a very important question as to the effect of such freezing, and the writer has never seen any deleterious results in ordinary soil where the road bed had been drained by a ditch, whose bottom was 18 ins. below the crown of the road. As to theory, it seems probable that any expansion of the moisture in the voids of the earth upon freezing would be taken up by the 12-in. layer of dry earth between the frost and the macadam; and should it not be thus taken up, it would merely raise the whole surface of the road uniformly a fraction of an inch. It may be argued that "faulting" may be caused by the lateral pressure of frozen earth; if so, the line of weakness is in the ditch where the bulging will occur and not under the macadam; and it is erroneous to assume that expansion will take place along the axis of the road, for ice melts under pressure and flows toward the point of least resistance.

Since the writer formulated this theory to account for the fact that freezing does not injure macadam, even where shallow ditches are used, he has received conclusive proof of its truth.

Prof. Daniel B. Luten's recent experiments upon the expansion of gravel, sand and loam, saturated with water, and frozen in an iron tube, 36 ins. long, filled to within 5 ins. of the top, showed an expansion of ⅛-in. with gravel, ⅛-in. with loam, and an imperceptible amount with sand. The rest of the expansion was taken up by forcing water up through the earth and forming a plug of ice at the top of the tube; a 1-in. ice plug on the gravel, a ¼-in. plug on the loam, and a ⅛-in. plug on the sand.

Under a road, when freezing begins, the expansion, in a similar manner, will force a small amount of water up into the voids of the dry layer beneath the macadam, out into the ditches, and down into the earth below, thus causing no perceptible heaving of the macadam. It must be remembered that a soil is seldom saturated with water as in these experiments and therefore little or no expansion of the soil itself will take place under ordinary conditions. Since it is evident that deep ditches are usually unnecessary, it follows that broad shallow ditches are better, not only because less earth need be moved to form them, but because by giving the ditch a broad (24-in.) bottom, drag scrapers can be used in moving the earth. This leads to another criticism of the common design of road cross section as made by engineers who seem not to have considered the great economy attending the use of drag and wheel scrapers and road machines. Deep, narrow bottomed ditches, and the "shoulders" upon each side of the macadam, shown in Fig. 1, render the use of such machines generally impracticable. The wheel scraper is the greatest labor-saving device for moving earth short distances that was ever invented and road machines and leveling scrapers stand second only in point of merit. It can be safely said that where these machines can be used the cost of earth work will be not over two-thirds what it is where pick and shovel work is necessary. Wide, shallow ditches are favorable to the use of drag and wheel scrapers, and all that remains to render the use of leveling machines possible is a gentle curving cross section profile of the finished earth surface, as shown in Fig. 2.

The cross section of the ditch shown in Fig. 2 will give sufficient earth to build the embankment forming the earth road. Here again the engineer is very likely to err, particularly if his training has been in railroad work. He will balance his cuts and fills on the longitudinal profile of the road, and entirely forget the large amount of earth

*Extract from a book entitled "The Economics of Road Construction," issued by the Engineering News Publishing Co.

†Rochester, N. Y.

‡The half-tone illustrations presented, together with the explanations and comments beneath the titles, illustrate the two types of cross section, as shown by completed macadam roads.

that will come from the ditches. It is therefore a good rule to balance in the usual way the cuts and fills on the profile of the center, and afterward raise the grade about 3 to 6 ins. all along the road, to make room for the earth from the ditches. While Fig. 2 may be taken as a standard cross section, it should be modified to suit local conditions. In very wet, soggy soil, or where the drainage area of the ditches is great, the ditches must of course be made larger; while in very sandy soil little ditching is required, for a certain amount of moisture in sand is desirable to hold it together.

LONGITUDINAL PROFILE.—Another common error made by railroad and canal engineers is to design level or nearly level grades for long stretches of the road. In road work, however, the minimum grade should be ½% to secure longitudinal drainage of any incipient ruts that may form in the road surface; and this is especially necessary in cuts where the water seeps through and runs down the slopes of the cut, frequently washing ditches full of earth where they have only a slight grade. This leads us to the consideration of cuts.

Deep cuts form the most expensive portions of a road, both in first cost and maintenance. To reduce the first cost of earth work in cuts, the surface ditches should be narrowed until they are merely gutters.

GUTTERS AND DRAINS.—Gutters must be paved with cobblestone on grades of 2% or more. Underneath the gutter tile drains must be placed to carry the water fed by the ditches above the cut. It should be observed that after every heavy fall of snow the mouth of all such drains and all pipe culverts must be cleaned out, otherwise water will dam back and under pressure will either overflow the road or follow along the pipe and undermine it, causing bad settlements.

Regarding the width of the road, it should never be less than 15 ft. between ditches, and preferably 22 ft. or more. The surface should not have a side slope greater than ½-in. in 12 ins., otherwise traffic will follow the ridge in the center, and more quickly wear it out.

EMBANKMENTS.—We come now to the formation of embankments. The scissors and paste pot engineers usually specify that all material of vegetable nature must be carefully excluded from the embankments. This is unnecessary and adds immensely to the cost where the road passes through meadow land. It is of course desirable to remove brush, large roots and high weeds; but the writer has built embankments in the densely timbered and brushy country of Western Washington, where no efforts were made to exclude small twigs and sod, and after eight years embankments showed no undesirable settlement. An embankment built with wheel or drag scrapers, wagons and horses, needs no rolling until its surface is shaped and ready for completion; indeed the "sectional iron roller," often specified, will produce no greater consolidation than will the wheels and hoofs. An embankment need not be made in horizontal or concave layers, as frequently required by the engineer. All such "sandpapering" is the work of a theorist, which experience proves unnecessary.

In passing, the writer will call attention to a common error, namely, that embankments shrink some 10% after construction.

Embankments made with pick and shovel and wheelbarrows do settle under the puddling action of rain, but in embankments made by teams the shrinkage takes place almost entirely during the construction, under the pounding of hoofs and wheels; and even very high embankments so constructed do not ordinarily settle over 2% afterwards. The error has probably arisen from consideration of investigations of Morris and others, showing a shrinkage of 10% when earth is taken from "cut" and put into "fill." It is true that shrinkage takes place, but the shrinkage occurs during the process of construction, not afterwards.*

COST OF EARTHWORK.—The data of Morris, as copied and erroneously modified by Trautwine, are so commonly quoted as being exact enough for practical purposes that the writer wishes here to state that not one of Trautwine's tables of costs comes within 25% to 50% of the truth for short hauls, either with carts, scrapers or wheelbarrows. Trautwine unfortunately underestimates the cost of all earthwork except for long hauls; and there his tables are useless, since two-horse wagons, which he does not mention, are cheaper than carts. The writer will publish shortly a hand-book for engineers and contractors giving all his data and conclusions in full; but for the present purpose it will suffice first to point out some of the causes of Trautwine's errors; and, second, to give the writer's own rules for estimating costs.

Trautwine errs (1) in assuming that a wheel scraper or drag scraper holds the amount of earth that its catalogue size would indicate, because it will usually not go out full; and even if it does it is full of loose ploughed earth that will shrink 25% when rolled and packed by hoofs and wheels; he errs (2) in too low estimates of time lost each trip in loading and unloading; he errs (3) in the speed of horses going at a walk; they travel not 150 ft. a minute, as stated by him, but 220 ft., which in a measure counterbalances some of his other errors in short hauls; he errs (4) in assuming that one driver can look after three or more carts. In Trautwine's table of costs of moving earth with drag scrapers it is stated that with leads of 40 ft. one drag scraper will move 220 cu. yds. in 10 hours, which is absolutely impossible. The writer has never seen more than 70 cu. yds. moved with one scraper in a day, and then only in the easiest of soil and with shortest of hauls. It is high time that engineers should cease quoting such erroneous tables of costs—tables that have caused many contractors great financial loss.

The following are the writer's rules for ascertaining cost of moving earth, not including superintendence or contractor's profits, wages of laborers being 15 cts. per hour; of team and driver, 35 cts. per hour:

The length of lead is measured in feet from the center of gravity of the cut to the center of gravity of the embankment, no allowance being made for turning around at either end, as this is included in the "fixed cost."

The fixed cost includes cost of loosening, loading, dumping, spreading and lost time of men and teams, but does not include superintendence or contractor's profits and use of tools, for which at least 25% should be added. It is absurd to talk of 10% or 15% profit in earthwork, especially in a new and unknown soil.

A team can travel at a walk 25 miles in 10 hours, or at a speed of 220 ft. a minute. A laborer will load with a shovel about 15 cu. yds. (place measurement) of ploughed earth in 10 hours.

A plough, team and driver, with one man holding the plough, will loosen 400 cu. yds. of ordinary earth in a day; but if the hard earth crust of an old road must be loosened it will take two teams, one man riding the beam and one plough holder, to loosen about 150 cu. yds. a day.

The fixed cost of moving ordinary earth with wagons is therefore as follows:

Loading wagon	10	cts.	per cu. yd.
Ploughing	1	"	" "
Spreading	2	"	" "
Time lost waiting to load and unload	5	"	" "
Total fixed cost of earth in wagon	18	"	" "

To this 18 cts. add 4 to 6 cts. if very tough clay or old compacted crust must be ploughed. The cost of hauling is as follows: In soft loose soils, where wagons must be pulled up steep (10%) embankments, ⅝ cu. yds., place measure, is an average load, while over fair earth roads with steep pull 1 cu. yd. forms a load; on hard level earth roads, 1¼ cu. yds. is a load.

RULE.—To the fixed cost of 18 to 22 cts. per cu. yd. in the wagon add 0.8 cts. per 100 ft. of lead in soft roads, 0.55 cts. per cu. yd. per 100 ft. over fair roads, and 0.4 cts. per cu. yd. per 100 ft. over good earth roads.

Drag scrapers hold on an average only 0.1 cu. yd., and the fixed cost is about 10 cts. per cu. yd. of ordinary earth for leads of 100 ft. or less, to which add 6 cts. per cu. yd. per 100 ft. additional lead.

No. 1 wheel scrapers average 0.2 cu. yd. per load, and the fixed cost of earth in the wheeler is 10 cts. per cu. yd. for 100 ft. lead or less, to which add 3 cts. per cu. yd. for each additional 100 ft. lead.

No. 2 wheel scrapers average 0.25 cu. yd. per load, so that the cost of hauling is 2½ cts. per 100 ft.; but where a snatch team is necessary in loading 3 cts. per cu. yd. is added to the fixed cost.

To these figures for cost by scrapers or wheelers add 5 cts. if tough clay or hard road crust must be excavated.

A study of the above will disclose the fact that for short hauls no method compares in economy with the drag and wheel scrapers; indeed earth can be moved for about two-thirds what it will cost by wagons, up to 200 ft. lead.

SURFACING.—The surface of the subgrade should be leveled either with a Shuart grader or one of the common road machines. In cuts the ploughing should extend below the subgrade to loosen up the earth so that the blade of the machine will more easily fill up the depressions. A grader will readily level 25,000 sq. yds. in a day at a cost of 0.02 cts. per sq. yd. If the earth road thus prepared is to be macadamized, it should be thoroughly rolled with a steam roller, so that no stone will be afterward pushed down into the earth. The contractor cannot be too painstaking in this respect for his pocket-

*For a discussion of earth shrinkage, see Engineering News, Nov. 15 and 22, Dec. 13 and 20, 1900.

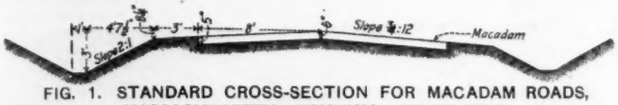


FIG. 1. STANDARD CROSS-SECTION FOR MACADAM ROADS, MASSACHUSETTS HIGHWAY COMMISSION.

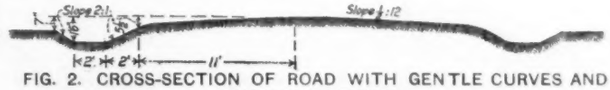


FIG. 2. CROSS-SECTION OF ROAD WITH GENTLE CURVES AND SHALLOW DITCHES.

FIG. 3. MACADAM ROAD WITH DEEP DITCHES.

(Showing a New York state macadam road of "standard cross-section" with ditches of extreme narrowness at the bottom, and of unnecessary depth. Owing to not balancing cuts and fills, material has been wasted outside of ditch line and in front of fence lines.)

FIG. 4. MACADAM ROAD WITH SHALLOW DITCHES.

(Showing macadam (6 ins. x 16 ft.) road without ditches; earth shoulders 7 ft. wide; crown of road 15 ins. above bottom of earth gutter.)

book's sake if he is to be paid for the stone by the cubic yard in place

In loose sand the roller cannot be used at all without first covering the sand with a layer of clay or loam, or thoroughly soaking the sand with water, the latter practice often being very expensive. An inch of fine dust spread over the sand and washed in to fill the voids will be found effective and usually less expensive than the use of cotton cheese cloth recommended by Massachusetts engineers. Half-inch to 1¼-in. screenings from the crusher may also be used to advantage; for by spreading a layer one stone thick and rolling it no more stone will be lost in the subgrade. A thin coating of straw has also been used to hold up the macadam on a sandy soil, and other expedients will suggest themselves to the engineer not hide-bound by precedent.

We have thus far considered the itemized cost of moving earth and forming the surface. The following two examples taken from the writer's timebooks show the total cost of grading a mile of road under varying conditions. The first case shows cost of work done with wheel the drag scrapers and graders where the cross section was that of Fig. 2, designed by the writer.

CASE I.—Cost of grading and surfacing one mile of road in ordinary earth, gravel and clay:

90 days, team and driver on scrapers, at	$3.50	$315
60 days, labor on scraper	1.50	90
10 days, foreman	2.50	25
Total, 3,000 cu. yds. excavated at 14⅓		$430

In Case I. all hauls were short, none being over 500 ft., and the average not over 200 ft.; no "sandpapering" of slopes was required, but a good, substantial workmanlike job throughout.

CASE II.—In this case deep ditches were dug and carefully trimmed, the cross section being like Fig. 1. As the time sheet shows, there was very little teaming, but nearly all hand work. Cost of grading and surfacing one mile:

60 days, team and driver, on plough and wagon, at	$3.50	$210
400 days' labor	1.50	600
40 days, foreman	2.50	100
Total, 4,500 cu. yds. excavated at .22 1-5		$1,000

There was less hauling in Case II. than in Case I., but most of the earth was either wasted on the sides of the ditches or thrown directly into the road, and careful trimming was required, while the shoulders and general form of the cross section made it impossible to use graders.

These two cases strikingly and accurately illustrate the difference between good and bad engineering design. In Case I., using wheel scrapers, a good road was built with 30% less excavation and at 35% less cost per cubic yard than in Case II., proving the writer's contention that road design, so far as earthwork is concerned, may be greatly improved both in Massachusetts and New York state.

The cost of earthwork and of earth roads has been discussed, not to advocate a road surfaced with earth, but because an earth road must be made upon which to build the macadam or Telford pavement. An unpaved earth road will, it is true, remain in good condition when traveled by wide-tired wagons until the fall rains begin to soak its surface, when nothing can prevent rutting first, and disintegration by frost afterward.

It is frequently stated that an earth road is as good as any other kind of road if kept well drained and free from ruts, which reminds the writer of an old saying that a certain bronze eagle in Salt Lake City "flies down to get a drink every time it hears the town clock strike." The statements are true in both cases, but the conditions are equally impossible of fulfilment.

It is not a fact that an earth road is as good as any other type, even if kept free from ruts, as the accompanying table of the number of pounds tractive force necessary to pull a ton over different surfaces clearly shows:

Street-car tramway	20 lbs.
Asphalt	25 "
Stone or wood block pavement (good)	30 "
Macadam or plank road (good)	35 "
Macadam or plank road (poor)	50 "
Gravel, good hard road	75 "
Clay, good hard road	100 "
Earth, loose	300 "

It is evident that even with the best earth road only half as great a load can be hauled as on a good macadam road, which is in itself sufficient to condemn an earth road for any but a poverty-stricken community.

TRACTION AND TRACTIVE POWER.—This leads naturally to a brief consideration of traction and tractive power. All authorities agree that a horse cannot exert a continuous pull of more than 100 to 150 lbs. for eight to ten hours going at a speed of 2¼ miles an hour, and authorities state that for a short period of time a horse may exert double his average tractive force, or about 250 lbs.

The writer has found that a horse may exert 500 lbs. tractive force without injury for at least two hours out of ten. He has used a team for raising a 2,000-lb. pile hammer where the power was multiplied three times by pulleys and the team has worked about three hours a day, actually lifting a weight equivalent to about 666 lbs. dead lift, which, with friction, was not less than 1,000 lbs. tractive force exerted by the team. Tests made by the U. S. Agricultural Department showed that a small pair of mules exerted a continuous pull on a trachometer of 1,000 lbs. while hauling a wagon up a steep hill. (See Fig. 6 for a view of a finished macadam road with 5.3% grade.)

It may be safely said, therefore, that a team can exert four times as much tractive energy going up a short hill as its average pull upon the level. Each added 1% of grade is equivalent to an added resistance to traction of about 20 lbs. per ton; therefore, if the average load of a wagon is 8,500 lbs. and the weight of the wagon is 1,500 lbs., the tractive force necessary to pull it over a good macadam road on the level would be 175 lbs., or over a poor macadam road, 250 lbs., which would still leave about 750 lbs. available tractive force that a team could exert going up a short hill, such a hill having a grade of 7½%. It is probable that on a smooth macadam road, and on a grade as steep as 7½%, the horses might slip and fall, so that some allowance should be made for this contingency.

It is seldom, however, that any such loads as this are hauled even over good roads, simply for the reason that there are usually stretches of poor road to be traveled by the farmer before the good road is reached; and for many years to come, certainly not within the life of macadam pavements built in the next few years, the average net load will probably not exceed three tons, which would enable a team to climb a short 8% grade without overtaxing its energies. Since it is generally a few short deep cuts that adds so greatly to the cost of a road it would seem to be good engineering not to endeavor to reduce the grades where much earthwork is necessary, without careful consideration of the above stated facts. A 2% or 3% grade forms a desirable maximum if it can be cheaply obtained, since 2% or 3% is the slope of repose of a wagon on a macadam surface, and a horse can in consequence readily trot down such a grade.

Having considered the design of cross section, the cost of excavation and surfacing, and the selection of maximum grades or design of profile, let us now briefly consider the subject of the general location of the road.

LOCATION.—Upon this subject alone a volume could be written, but much already exists in print and it is not the purpose of the writer to "re-hash" but rather to call attention to facts which hitherto have not received publication, or if published have not become generally known.

Few existing roads are well located. They are built after the style of the Romans, going over hills rather than around them. Any civil engineer would remedy such a glaring defect if given the opportunity; but there is one point in location that the engineer is almost certain to overlook if his experience has been in railroad work, namely, the character of the soil over which the road runs. Upon one side of a valley the surface may be clay, upon the opposite side gravel; in the bottom of the valley the soil is usually alluvial, higher up on a bench it is generally far more fit for road purposes. The experienced engineer will therefore not select the final location of a road until he has studied sub-surface conditions as well as topography. In locating a road in a new country the engineer will also bear in mind the fact that one of the greatest items of cost of a gravel or macadam road is the hauling of material, and will locate his road near the gravel pits or proposed quarry, wherever possible. A few culverts or drains or a few bridges will greatly swell the cost per mile of road, and these likewise the engineer will avoid if possible; and where necessary will build them as cheaply as may be, using vitrified pipe or timber for small culverts, instead of masonry arches or iron pipe; using steel I-beams with wooden floors for bridges under 30-ft. span, instead of the expensive Pony trusses so common in the Eastern states. It is not unusual to see highway bridges of 60 ft. or more span over streams that never carry much driftwood or ice (the greatest destroyers of piers) where two or more 30-ft. spans resting on pile foundations would suffice, at far less expense. Bridges may frequently be avoided entirely by diverting the stream, which is a common and economic expedient in the far West.

To sum up this chapter, we find: (1) A uniform cross section for all parts of the road should not be adopted. The depth of ditches should be made to vary with the character of the soil, very shallow in sand or on steep grades and deep in flat soggy lands, but ordinarily not much more than a foot below the general ground level. The ditches should be wide enough to permit the use of

FIG. 5. DEEP DITCH AND CULVERT PARTIALLY FILLED WITH DIRT WASHINGS.

(Showing 12-in. culvert on New York state road after nature has begun to obliterate unsightly ditches. If it is argued that so large a ditch is necessary to carry the surface water, why are culverts made of less than one-eighth the carrying capacity of the ditch?)

FIG. 6. MACADAM ROAD ON STEEP GRADE, WITH SHALLOW-PAVED GUTTERS.

(Showing macadam (6 ins. × 12 ft.) road with broken stone gutters (4 ins. × 5 ft.) on 5.3% grade up which a team hauls a gross load of 12,000 lbs., exerting a tractive force of not less than 800 lbs.)

FIG. 7. TYPICAL CROSS-SECTION OF MACADAM ROAD, AS RECOMMENDED BY THE AUTHOR.

drag and wheel-scrapers, and engineers should cease blindly copying plans made long before the invention of the wheel scraper and other labor-saving devices.

(2) Freezing of the soil does not destroy a macadam or other road crust, provided that there is 1 ft. of dry earth beneath the macadam.

(3) The cuts and fills should be balanced, including the earth from the ditches. No sandpapering of slopes and embankments should be specified.

(4) Select a profile with a minimum grade of ½% and a maximum grade of 3%, if it can be obtained at nominal cost; but up to 5% or even 8% if necessary to avoid excessive excavation, for the tractive power of a horse is not a constant quantity and is greater than authorities state.

(5) Design a rather flat arch for the road surface, with a total crown or drop of ½-in. in 12 ins., and avoid any shoulders or trenches in the cross section. Thus will it be possible to do the surfacing by horse instead of by man power.

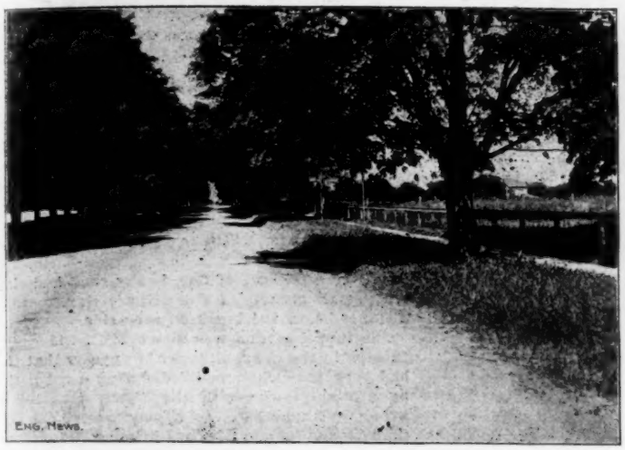


FIG. 8. MACADAM ROAD WITH SHALLOW DITCHES, AFTER WINTER'S USE.

(Showing macadam (12 ins. × 18 ft.) road without ditches; earth shoulders, 9 ft. wide; crown of road only 15 ins. above bottom of gutter. Road in perfect condition after severe winter and wet spring.)

FIG. 9. ANOTHER EXAMPLE OF SHALLOW DITCHES.

(Showing macadam (6 ins. × 16 ft.) road; no ditches; earth shoulders, 5 ft. wide; crown 9 ins. above gutters. Macadam perfect after severe winter and wet spring.)

(6) Locate the road with due regard to the character of underlying soil, shifting it where possible to secure better material both for sub-grade and for surfacing.

(7) Cut down the cost of all culverts and bridges as low as possible, both by careful location of the road and by economy in the design of culverts and bridges.

THE HAY STEEL PROCESS AND THE FIRST STEEL BRIDGE IN AMERICA.

In the article in our issue of March 14, 1901, describing the reconstruction of the Chicago & Alton Ry. bridge across the Missouri River at Glasgow, Mo., reference was made briefly to the fact that this structure as originally built was claimed to have been the first steel bridge built in America. Some interesting evidence in support of this claim, and incidentally relating to Mr. A T. Hay, and the early history of Hay steel, was given by Gen. Wm. Sooy Smith, the Chief Engineer of the original bridge, in a recent discussion before the Western Society of Engineers.* The remarks of Mr. Smith and of those who followed him in this discussion so far as they relate to the two subjects named, were as follows:

Gen. W. Sooy Smith.—The superstructure is really far the more important and interesting part of this bridge, as it was the first great steel bridge that was ever built—in fact, the first steel bridge of any importance built in the world, and I think it would be interesting to the society to know something of the origin of the idea and its gradual growth, until it finally culminated in the construction of that superstructure.

In the year 1872 the convention of the American Society of Civil Engineers was held in this city. Most of us who had been grappling with the difficulties that attended iron bridge construction—that was my specialty in the beginning of my professional work—were anxious to devise some means for solving the problem of iron in the construction of iron bridges. The continuation of those difficulties had led us to consider some way out of it. The defects of iron were so marked that iron bridges had a hard struggle to compete with the best wooden bridges, and the progress made by them was very slow. The iron, crystallized rapidly, and bridges that had been built of ample strength had the character of the metal been good, failed in a surprising way; brought iron bridges into disrepute, and turned the attention of the best engineers in Europe, or in the world, to the matter of either correcting those defects in the iron or substituting some other material that would be free from them.

I had the honor to offer a resolution in that convention, just at the close of its final meeting, calling for the appointment of a committee of the society, whose duty it should be to procure from the United States government, if possible, an appropriation for the building of a first-class testing machine, and the appointment of a mixed board of engineers from the army, the navy and the civil engineers, to take that testing machine and to make a series of tests which would be comprehensive and exhaustive, to determine the quality of the various metals, not only of iron and steel, but all other materials used in the construction of bridges, in this country. The resolution passed unanimously, and parliamentary usage made me the chairman of the committee. There was associated with me Generals McClellan and Barnard and Albert Fink and Jas. B. Eads. For three years we struggled with Congress, aided by the American Society of Civil Engineers, to secure the appropriation. The board was appointed in pursuance of the bill and an appropriation of $75,000 was made for the machine. This machine is at the Watertown arsenal, and is subject to use by anybody who cares to do so.

Shortly after the appointment of the board I received a letter from an old gentleman at Burlington, Ia., altogether unknown to fame, a gentleman by the name of A. T. Hay. He wrote me that for 12 years he had been engaged in his quiet way, making tests upon iron and steel, and that he had succeeded in making various new alloys of iron and steel which showed most remarkable qualities. I sent a copy of the letter to the Board and asked their pleasure with regard to it, and they instructed me to invite Mr. Hay to a conference. This I did, and he came here, bringing some specimens wih him. We examined these specimens together from 2 o'clock one afternoon until bright daylight the next morning, during which time I learned something and had my curiosity raised to a fever heat. He told me that for 12 years he had used an electrical furnace, as he termed it, for fusing ores, and that by means of it he had combined iron with each of 14 metalloids to form compounds, in various proportions, and had tested the results very carefully.

Some of the specimens of the steel he had made showed an ultimate strength of 100,000 lbs. per sq. in. I was so much interested that I went to Burlington to see his apparatus, which consisted of two concentric cylinders of sheet iron, the inner one lined with fire brick, built as any furnace should be. The inner cylinder was not over 2½ ft. in diameter and about 4 or 5 ft. high. In the space between the inner and the outer cylinders he had coiled wires in positions he had learned by actual use were correct. Just how he used the current in aiding the fusion of the ores I could not discover at the time, nor at any time since; but in my presence he charged this furnace, put on the blast and heated the contents to redness without any appearance of fusion. "And now," he said, "I will show you the effect of electricity." He connected up his current and immediately the contents commenced streaming down like wax. After he made those alloys he hammered them into bars and had the bars tested in Chicago. He sent me a specimen, which I carefully tested, and for three months we were engaged in investigation of the qualities of the steel which he produced, and at the end of it I determined that one of those alloys out of the many specimens which he made was exactly the metal that we had been looking for for bridge building, and I so reported to Mr. Blackstone, the president of the Chicago & Alton, who had asked me to take charge of the Glasgow bridge as chief engineer.

In that connection I may state one other fact. Before reaching that conclusion for this particular bridge, I asked Mr. Blackstone to witness a test of some of the steel bars which Mr. Hay had sent me. We went to the American Bridge Works and broke them, and the last one, just 1 in. square, stood a test of 90,000 lbs. Mr. Blackstone said at once: "Build the bridge of that material." This test was made at a very low temperature, it was an exceedingly cold day, and the bar was broken in a cold room. During many of our tests at a low temperature the specimens were struck sharp blows with hammers.

When I concluded to build the bridge of steel and it became known, some of the best iron bridge builders in this country protested against it. Notwithstanding the protests, it was determined to build it in steel. It remained in use for over 20 years without one single show of weakness anywhere, and during that 20 years the loads passing over it were almost doubled.

A little more information with regard to the superstructure and I am done. Instead of adopting the factor of 5 to 6, taken from the ultimate strength, I chose to use one-third of the elastic limit, which gave 16,000 lbs. per sq. in., and the parts of the bridge were proportioned by that rule. The maximum stress allowed at that time in iron bridges was 12,000 lbs. per sq. in. The weight of steel compared with that of iron for a truss of the same length would therefore be as 12 is to 16, or 25% less.

The quality of the steel developed by Hay at that time was just as high is it is now. He never was treated as he deserved to be, although he superintended, at the Joliet works, the making of several hundred tons of steel rails that proved remarkably good. The steel-makers stood aloof from Mr. Hay, astonished, although I believe they got all the information they could and applied it and still apply it. The steels now made are more the result of the discoveries of old man Hay than from any other source of information ever opened to the world. He was, as I think, the father of the modern structural steels.

Mr. W. H. Finley.—I have always understood that the old draw span of the Chicago & Northwestern R. R. at Kinzie St., Chicago, was the first steel bridge erected in this country. It was built of the same steel as the Glasgow bridge, so I have been told. I have always understood that while the Glasgow bridge was started before the Kinzie St. bridge, the Kinzie St. bridge was erected first.

General Smith.—I think it was erected before the Glasgow bridge was completed, and by the same manufacturers, but the Glasgow bridge was planned long before, and partly erected before the Kinzie St. bridge. It was claimed that the same steel was used in it precisely. This I doubt. I have been told a number of times, when I have stated that the Glasgow bridge was the first steel bridge ever built, that I was mistaken—that there was some other steel bridge built over in Europe somewhere. If any of you know of any such instance I would be exceedingly obliged if you would give it to me. I do not believe that there ever was a bridge built of steel before the Glasgow bridge. The St. Louis bridge came as near as any. The tubes there are steel, but it is used in a different manner, in compression only. All the rest of the bridge is iron. In the Glasgow bridge every pound of it, every ounce of it was steel—the plates, the rods, the rivets, even the name plate. I was determined

*"The Substructure of Glasgow Bridge over the Missouri River," by H. P. Boardman, paper and discussion, "Journal of the Western Society of Engineers," April, 1901.

A NEW UNIVERSAL RACHET DRILL.

A ratchet drill designed to be stronger and more rapid in operation than the ordinary tool of this sort, and at the same time capable of ready use in very restricted spaces, is shown by the accompanying illustrations. Fig. 1 is a view of the drill ready for a downward stroke. Fig. 2 shows the ratchet mechanism, with its five spring-actuated pawls.

The universal motion is secured by placing the axis of the two trunnions on which the handle turns at an acute angle with the axis of the drill. A back and forth motion of the handle in any direction for about 2 ins. will operate the drill, while by setting a screw in the handle in one of three countersinks in the outside of the ratchet case, a rigid handle is secured.

In the ratchet shown, which is 1¾ ins. in diameter, there are twelve 1½-in. teeth. There are five pawls, engaging one at a time, making 60 catches in each revolution, and saving lost motion. The feed screw on the larger drills is provided with a shoulder, so it cannot be unscrewed so far, to avoid resetting, as to spoil the end threads. The regular handle has its end 16 ins. from the middle of the ratchet, but provision may be made for extending it, or for substituting a shorter one. The tool capable of drilling a 2-in. hole weighs but 11 lbs., but a smaller one is made which weighs only 4 lbs. with a steam pipe handle and 3 lbs. without the handle. This smaller tool measures but 3 ins. across the head, so a hole may be drilled within 1½ ins. of a side wall.

Fig. 1. General View of Universal Ratchet Drill.

Aside from a great variety of shop and bridge work, this drill is applicable for tapping water and other pipes, particularly in restricted spaces and in positions not readily accessible. It is made by the Waterbury Tool Co., of Waterbury, Conn., and is known as the Williams universal ratchet drill.

THE BUREAU OF FORESTRY, as a distinct division of the U. S. Department of Agriculture, was authorized by the last Congress, and $185,440 was appropriated for its maintenance. The appropriation for the previous Division of Forestry was $88,520; and for 1898-99 it had only $28,520. But this Division of Forestry made an assured success of practical forestry, and led to many improvements in forest management. Field work is to go on in 17 states this summer, with 179 persons engaged in the work of the bureau, 81 of these being student assistants, or young men who are preparing to take up forestry as a profession. The matters studied are tree planting, the relation of forests to the volume of streams, erosion, evaporation, irrigation, water supply, regulation of grazing lands, study of forest fires, etc.

PLANS FOR A NEW SEA-GOING BATTLESHIP will be submitted to the next Congress by the Naval Board on Construction; though the board is not unanimous on the subject of armament and its disposition. This warship will be larger than anything now in our navy. The general dimensions are as follows: Length, 450 ft.; beam, 76 ft.; mean draft, 24 ft. 6 ins.; displacement, 15,560 tons. The hull alone will weigh 7,000 tons, and the protective armor 3,700 tons. The coal capacity will be 2,000 tons; total load displacement 16,900 tons; deep-load draft, 26 ft. 4 ins.; indicated horse-power, 20,000; speed, 19 knots. The majority of the board recommends a battery of four 12-in. guns in two armored turrets, 20 7-in. guns in casemates and 20 3-in. guns. Eight of the 7-in. guns would be in individual armor, four on the upper deck and four on the gun-deck, firing ahead and astern. The other 12 guns would be in a central casemate. The machinery would be protected by 10-in. armor, tapering to 4 ins. fore and aft; the other armor would be 7 and 6 ins. thick, except on the 12-in. turrets, where it would be 10 ins. thick. The minority of the board recommends superimposed turrets with 12 and 8-in. guns, and a broadside of 6-in. guns.

AN ATLANTIC RECORD OF 23.51 KNOTS, between New York and Plymouth, was made by the Hamburg-American steamship "Deutschland" in the run ending July 11. She made the trip in 5 d. 11 h. 5 m., or an average of 23.51 knots for the voyage, with 557 knots as the maximum day's run. The weather was calm and favorable. The previous quickest trip between the same points was 5 d. 7 h. 31 m. over the short course of 2,980 knots. If the "Deutschland" had followed this same course on her last voyage she would have made the trip in 5 d. 3 h. The daily runs of this steamer on her last trip were—479, 557, 551, 544, 550 and 401 knots. Her average hourly speed on the day she made 557 knots was about 24 knots—allowing 23 h. 10 m. as the length of the nautical day going east.

THE SPANISH FLOATING DOCK, for Port Mahon, Minorca, has just been completed by Robt. Stephenson & Co., of Hebburn-on-Tyne. It was originally ordered by the Spanish government for the Philippine Islands, but circumstances have changed its location. The dock is designed to lift a ship of 12,000 tons, with a length of 328 ft. And with this load no part of the dock is strained more than 6.33 tons per sq. in. in tension, or 7.6 tons per sq. in. in compression. The length between perpendiculars is 450 ft.; molded beam over pontoons, 117 ft.; molded depth of pontoons, 13½ ft.; distance between shoring platforms, 85 ft. The bottom part is made of six iron pontoons each 74 ft. 2 ins. long by 117 ft wide, by 13½ ft. molded depth. These pontoons have bulkheads, making 68 water-tight compartments. On top of these are steel side-girders, or towers, with a safety deck about 14 ft. above the pontoons. Each tower is also divided into 10 water-tight compartments. In the center compartment of each tower are two Tangyes 24-in. centrifugal pumps; two marine boilers, working at 120 lbs. pressure; two separate engines; a duplex drainage pump and fire pump; two duplex donkey pumps and a feed-water heater. These four main centrifugal pumps can throw 23,000 tons of water in two hours against an 88-ft. head. The dock is so constructed that if any pontoon is damaged or needs painting, it can be detached and docked on the dock itself, by disconnecting bolts; sinking it below the dock bottom; pulling it out at the sides, and then sinking the dock sufficiently to allow the pontoon to float in endways.

EXPORTS FROM THE UNITED STATES to Central and South America have not grown as they have in other directions, says the U. S. Bureau of Statistics. The total exports to South America in 1900 did not exceed those of 1890, both being about $38,000,000; the same holds good for Central America. But with Mexico and the West Indies our trade has largely increased in the decade 1890-1900. In 1890 our exports to the West Indies were worth $33,000,000, and in 1900, $47,000,000; and in the same period our exports to Mexico increased from $13,000,000 to $34,000,000. In the fiscal year 1900-1901, our total exports to Mexico, Central and South American and the West Indies amounted to $103,000,000 in 1899, to $127,000,000 in 1900, and $138,000,000 in 1901. The importance of satisfactory transportation facilities is well illustrated in the case of Mexico. Prior to railway connection with the United States, our exports to Mexico seldom reached $10,000,000 in value; by 1896 they were $20,000,000; by 1899, $25,000,000, and by 1901, $37,000,000. The same statement holds good for the West Indies, to which country our transportation system is in much more satisfactory condition than that to Central and South America.

THE CHESTER STEEL TIE, which was illustrated and described in Engineering News of July 19, 1900, has been reported upon by the Committee on Science and the Arts of the Franklin Institute, Philadelphia, and the following abstract of the report is published in the Institute's "Journal:"

This device consists of an inverted T-bar of suitable weight and section, and for standard gage tracks, 6 ft. long. Near each end, the upper edge of this bar is slotted or notched out to receive the base of the rail, the outer edge of the notch being hook-shaped so as to fit over the flange of the rail. These two notches determine the gage of the track. Immediately under each notch is placed a bearing-plate or chair consisting of a steel plate ¼-in. to ⅜-in. thick, 12 ins. wide and 20 ins. long, bent down at the ends, forming inclined legs, about 5 ins. long. These bearing-plates are slotted out so that the tie or gage-bar can slip through them freely, and two cheek pieces or clips are stamped up from the under side, for the purpose of engaging with the inner base flange of the rail. No other fastenings of any kind are used. In laying the tracks, it is only necessary to distribute the ties along the roadbed with the bearing-plates or chairs clipped towards the center of the track far enough to permit the rails to be placed in the notches of the gage bars. When the rails are in position the bearing-plates are pushed out until the clips engage the inner flanges of the rail and the track is ready for tamping. The ballast alone is depended upon for holding the bars in position, the shape of the bearing-plates, it is claimed, being such as to insure this result. The report admits the device to be simple in construction and ingenious in design, but states the following objections to its practicability, viz.: The difficulty of opening and closing the gage around curves without a special set of ties for each curve; the difficulty of securing the track at switches and crossings; of maintaining an accurate gage owing to variations in the flanges of the rails and the wear in the notches; the necessity of supplying new ties for every change of rail section; the difficulty in taking out and replacing rails; and lastly, the impossibility of keeping the clamping devices tight under heavy and fast traffic. (Sub-Committee.—Thomas P. Conard, Chairman; Henry F. Colvin, Charles Day, E. H. Johnson.)

OUR FOREIGN COMMERCE for the fiscal year ending June 30 has increased in all directions save in the Pacific Ocean, says the Treasury Bureau of Statistics. Our exports to South America have increased $6,000,000; to North America, $10,000,000, and to Europe $100,000,000, as compared with the previous fiscal year. But to Asia and Oceanica there is an apparent falling off of exports amounting to over $20,000,000. The conditions in China have cut off one-half our exports to that country; and the over-purchase of cotton by Japan in the previous year have momentarily reduced our sales there. Our total exports to Asia and Oceanica, in the eleven months ending with May, 1900, amounted to $101,000,000; while in the corresponding months of the last fiscal year they only aggregated $76,000,000. But as existing law prevents the Treasury Bureau from presenting the exports to the Hawaiian Islands in the total of exports, and as these exports for the year will be fully $20,000,000, the actual falling off in Pacific export trade is really only about $4,000,000.

THE EXPORTS OF MANUFACTURES from the United States are officially less by $14,565,030, for the 11 months ending with May, 1901, than in the same period of the preceding year. But this statement is misleading, as the figures for 1901 do not include exports to Porto Rico and Hawaii, which were counted in 1900 and former years. As the exports to these two countries—largely manufactures—will aggregate $25,000,000 for the last fiscal year, the export of manufactures for 1901 really differs little in value from that of 1900. There is an actual reduction in the export of cotton and copper. The export of the former for the 11 months ending in May, 1901, was $17,275,299, as against $22,080,583 in 1900; a loss due to the temporary conditions in China. The export of copper fell $11,849,518 in value in the period named for 1901. The excess exports of 1901 over 1900 are—In steel rails a gain of $2,000,000; pig iron, $1,000,000; bars and steel rods, $1,500,000; electrical machinery, $1,500,000; boots and shoes, over $1,000,000; cottonseed oil, nearly $2,000,000; carriages and cars, $2,000,000; chemicals, over $1,000,000; scientific instruments, $1,000,000.

THE OLD MASON AND DIXON BOUNDARY LINE, between Pennsylvania and Maryland, is to be resurveyed and remarked with iron posts, under appropriations of $5,000 from Maryland, and $7,000 from Pennsylvania. The original line was surveyed in 1763-67, by Charles Mason and Jeremiah Dixon, two English surveyors sent over for that purpose. The original stone monuments set had a "P" on one side and an "M" on the other, with the coats of arms of William Penn and Lord Baltimore on every fifth milestone. These stone monuments have been much damaged, and they will be replaced by iron markers.

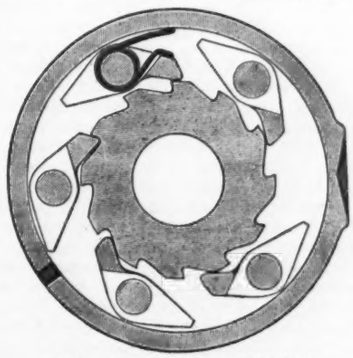


Fig. 2. Section Through Ratchet.

A TIE-HEWING MACHINE recently introduced has a series of cutters on two shafts which extend over and parallel with the bed or table upon which the tie or log is laid. The tie is gripped between headstocks, which are tightened by screws. The tie can be trimmed on two or four sides. The shafts are driven by a train of gearing operated by a belt wheel, a 20-HP. steam engine furnishing the power. The machine may be used in a mill or mounted on a wagon body and hauled into the woods by horses or a traction engine. The machine is built by the Salem Iron Works, of Salem, N. C.

that there should not be any sort of question as to its being a steel bridge.

Mr. W. H. Finley.—The order for the Kinzie St. draw of the C. & N. W. R. R. was placed with the American Bridge Co. in the early fall of 1878, and the bridge was put in operation March 10, 1879. The erection of the Glasgow bridge was completed April 9, 1879, or just one month after the Kinzie St. draw was put in operation. I was particularly struck with General Smith's description of Hay steel and his remarks about wrought iron. I do not think that I ever had a bridge under my charge that gave me more trouble, from the character of the material in it, than the Kinzie St. bridge. I had some tests made on that material after the old bridge was taken down. The chemical analyses showed 0.24% carbon, 0.038% silicon, 0.47% manganese, 0.106% phosphorus, 0.92% sulphur. A plate taken from the upper chord had 0.42% of carbon in it, and the average of the tests of the angles showed 74,500 lbs. tensile strength per sq. in., and of the plate 88,300 lbs. tensile strength per sq. in. The structure met with a number of accidents by being struck with boats, and when it was necessary to make repairs it required the utmost care not to do more damage in repairing it than there was originally. From my experience with it I would certainly say that it was a rather unsatisfactory material.

General Smith.—I said that that metal was identical with the metal used in the Glasgow bridge, but I don't believe it was. I don't know that it was under Mr. Hay's supervision. I do know that the tests of the metal that entered into the construction of the Glasgow bridge were most remarkable and thorough, every single piece of it tested by as able and as careful a man as I have ever known, Mr. Coolidge. I met him on the street the other day and he repeated what he told me before, and the report was that the uniformity was something wonderful.

We tested a great many parts of the metal to breaking, and we had a number of them that remained uniform throughout the length of 5 ft. until reduced from ½ to ¾-in. in cross-section—no reduction other than that at any one point. As I said, every single part of it was tested and tested carefully, and the quality of every single piece of it was found by such accurate tests to comply with the specifications which required that the ultimate strength should be 80,000 lbs.; the elongation before fracture 10%; greatest reduction at any point 10% of the cross-section. And the metal did fulfill that specification, and no metal that was not first-class would have done it. The conduct of the bridge itself showed throughout that the facts had justified all our best expectations with regard to it. There must have been some deception in the manufacture of the metal in the Kinzie St. bridge. The presence of 0.106% phosphorus and 0.92% sulphur was hurtful.

Mr. Finley.—I understood from Mr. Coolidge that it was the same as used in the Glasgow bridge.

General Smith.—He may have understood it so, but he did not make the steel. I suspect that steel was made clandestinely, by what was called Mr. Hay's process, to avoid the royalties that should have gone to him, and under such circumstances it is not strange that there should have been accidents.

Instead of recognizing the merit of it, and that that merit should go to his benefit, I know that it is used by a number of the best steel-makers in the world. The very formula used by Mr. Hay is very closely imitated in the best steel that is now made. Hay introduced, as a benefit, aluminum, nickel chromium, and other metals, relying very largely upon aluminum, and the best steel today is made with reliance upon the beneficial effects of such alloys. I ought to state that the carbon in the steel, according to our specifications, was about from 0.36 to 0.42%. There was another evidence of the superior quality of the metal furnished by the span that fell when the falsework was swept away; the span dropped 50 ft. into the water, and was twisted into all sorts of shapes that you can imagine, and there was not one single case of short fracture to be discovered in the whole wreck. Another thing, I am told that some parts of that metal were taken and made into tool-steel.

Mr. H. P. Boardman.—Relative to the remarks of General Smith and Mr. Finley concerning the steel of which the Glasgow bridge and the C. & N. W. Kinzie St. bridge were made, I quote the following extract from a letter by W. B. Coolidge to August Ziesing. Referring to the Glasgow bridge, he says:

> The steel was Hay steel, made at the Edgar Thompson Works by Carnegie & Co. for Hussey, Howe & Co., who rolled the plates and angles. The eye bars were rolled in the Kloman mill, and the eye forged and the whole bar then annealed. Tests were made on each blow of steel. Tensile strength 80,000 lbs. and upwards. The carbon required was 0.42%. The same material was used in the Kinzie St. bridge, but the carbon was about 0.30% or under, and rivets 0.15%. The records of tests were among the papers of the old American Bridge Co. at the works at 39th St., Chicago. This is the extent of my knowledge and recollection of the matter."

In this connection it should be noted that only the five 311 ft. spans were steel, the three approach deck truss spans and the plate girder trestle approaches being of iron.

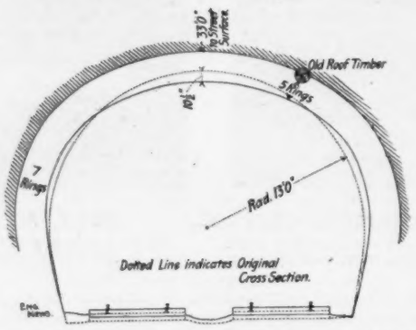
THE COLLAPSE OF THE PENNSYLVANIA RAILROAD TUNNEL IN BALTIMORE.

By Kenneth Allen, M. Am. Soc. C. E.

The arch over a portion of the Pennsylvania Railroad tunnel under Hoffman St., at Baltimore, Md., gave way at about 2 a. m., June 29, at a time when two trains were passing through, one of which was caught in the debris and unable to move until dug out. Fortunately no lives were lost or serious injury to individuals incurred.

A 4-in. water main was carried down with the street surface, flooding the tunnel in the vicinity. It was at first thought that a break in this main was probably the cause of the failure of the arch by the washing out of the earth backing. But as the pipe was laid in a 3-ft. trench, and no indications of a leak has been observed, while the top of the arch was 33 ft. below the surface, it has been admitted that this theory is at least improbable.

Mr. John C. Wrenshall, Assistant Engineer during the construction of the tunnel, mentions that considerable difficulty was encountered at this point during the original construction from a vein of quicksand, and that a large section caved in at that time. It was thought that the break in the water main would serve as a cause of contention, between the railroad and the city officials, but after investigation of the ground the railroad company promptly absolved the city form responsibility in the matter.



Cross-Section of Pennsylvania R. R. Tunnel at Baltimore, Md., at Point of Break.

The following extracts from the "Baltimore News" of July 10 describes in a general way the work that has been done in restoring the tunnel:

> The promptness with which the Union Tunnel was opened to traffic after the cave-in on June 29 last deserves to rank well among the feats of local engineering. When the workmen reached the corner of Central Ave. and Hoffman St. early on the morning of the accident a curious sight met their eyes. It seemed as if the bottom of Hoffman St. had dropped out. A chasm about 50 ft. deep, with almost perpendicular sides, extended to within two or three feet of the building line on each side of Hoffman St., and ran back from the intersection of that street with Central Ave. perhaps 70 ft.
>
> Appreciating the fact that if something were not done at once the sides of the pit might cave in farther, carrying with them the two corner houses and their occupants, the engineers began to "curb up" the sides of the hole with timbers about 18 ins. in diameter. These were lowered by ropes into place about one-third of the way down, and then a few daring men clambered gingerly down and nailed their ends together, using smaller timbers to brace them. This accomplished, other beams of the same size were lowered to brace those already set, and soon a row of heavy rafters was in place entirely across the mouth of the pit, with their ends against the other timbers which were lying along the sides.
>
> Two-inch planks were then driven down with sledges between the wooden "curbs" and the treacherous sides of the pit, and soon the hole began to look like a great box sunk in the bottom, without either ends or bottom.
>
> Then the hundreds of workmen went down with their picks and shovels, and in a short time had a series of great steps from the surface of the street to the bottom of the pit. Of course, these steps were only at the "ends" of the box, which, as has been said, was not supported with planks like the sides.
>
> One at first wondered what these steps were to be used for, but the question was soon answered when rows of perspiring men ranged themselves along the steps, shovel in hand. Those at the bottom threw the dirt by shovelfuls up to the step above them, where it was taken up and thrown to the next by the men on that step, and so on till it reached the street, where it was carted away. And all of this while Old Sol glared at them and drove the mercury up to 100 almost daily.
>
> Inside the tunnel, on each side of the place where thousands of tons of dirt had broken through the heavy masonry, gangs of men were at work loading dirt cars. And these were the men that suffered. Even the engineers in charge were unable to stand it long, and on the terrible Sunday, Monday and Tuesday the brave men struggled on in a temperature ranging from 100 up to 110° or perhaps 120°. As if the heat were not enough to make it a veritable Black Hole of Calcutta, nauseous gases permeated the place, so that no man could stand it over 20 minutes, even with a wet sponge tied across his mouth and nose.
>
> Once in awhile a poor fellow would throw down his pick and tell the foreman that he would have to give it up, or perhaps he would faint. In either case he would be carried out and attended by the company's physician and then sent home. As the hole connecting with the outer air grew larger the villainous gases disappeared and work inside became more bearable.
>
> On Thursday, July 4, nearly all the dirt had been taken out, and on Friday one of the imprisoned baggage cars was hauled out. Sunday the other car, which was the more severely damaged of the two, was dragged out. As soon as all the dirt was removed the masons set to work. A frame was put in place, and over it the new arch was begun. On Monday, July 8, ten days after the catastrophe, trains again began using the tunnel.

Investigations made by the City Water Department during the work have disclosed the following conditions:

The soil for from 6 ft. to 10 ft. below the street surface consists of a yellow, clayey earth, followed by a mixture of fine, loamy sand and clay, with small pockets of almost pure clay, to some distance below the break on each side.

The tunnel section was about 26 ft. wide by 20 ft. high in the clear, although it appears that this had been somewhat modified during construction by a slight lowering of the crown—probably to avoid the timbering. As it was, one of the roof timbers was found embedded in some two or three rings of the arch. The arch consisted of from five to seven rings of brick. At the east end of the break there were five rings inside the said roof timber, but as the latter sloped downwards towards the west, it would indicate that not over three rings were left entire between the timber and the soffit.

It was found that in the brickwork removed for repairs there was little or no cohesion between the mortar and many of the bricks, so that many bricks could be detached without the use of tools. This lack of cohesion was particularly evident between the first and second rings, and, in places, between the second and third rings, where the surfaces were plainly discolored by smoke.

The bonding appeared to have been insufficient, for in tearing out the arch east of the break a transverse joint was exposed without longitudinal toothing in the brickwork, the joints showing a deposit of smoke for five rings or more from the soffit.

As to the general condition of the arch, transverse cracks were noted, 15 to 20 ft. in length, both east and west of the break, and at the west there was a longitudinal crack some 20 or 25 ft. long and an inch wide.

Cracks in both sidewalks in Hoffman St. east of Central Ave. (the break occurring to the west of Central Ave.), indicate settlement. The walls of the house on the northeast corner of Hoffman St. and Central Ave. were condemned over two months ago, and have been rebuilt.*

A cast-iron post at the corner of this house has settled slightly, cracking the mosaic flooring in the doorway, while it has been necessary to vacate and shore up the house on the opposite side of the street. The break itself extends nearly to the property line each side of the street, and is about 70 or 80 ft. in length.

THIRTY FEET OF WATER AT LOW WATER in the improved New York Channel, from deep water below the Narrows to sea by way of Sandy Hook, is reported by Major W. L. Marshall, Engineer Corps, U. S. A. The general width of this channel is 1,000 ft. or more; and at Northwest Shoal the channel is 2,000 ft. wide. On the Ambrose Channel 16 ft. has been obtained.

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*The writer is indebted to Mr. A. M. Quick, Chief Engineer of the Baltimore Water Department, for the results of the investigations made by his department mentioned above.

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The Philadelphia Commercial Museum is reported to be in financial straits through the failure of the city authorities to provide funds for its maintenance. Several departments will have to be closed, but the Bureau of Information, which is supported by the contributions of manufacturers and exporters whom it supplies with news, will not be affected. The museum is an important enterprise; but it is a little doubtful whether the taxpayers of Philadelphia ought to be burdened with the support of an institution which benefits so limited a class. The purpose of the museum is to preserve and exhibit specimens of the principal goods used in foreign countries as a guide to American manufacturers who make goods for shipment abroad. Often, no doubt, it can perform a real service to manufactures; yet it is questionable whether any such institution can take the place of work by the manufacturer himself, especially since the era of consolidation began. Most concerns which are engaging in foreign trade nowadays have capital enough and are doing business on a large enough scale to obtain for themselves any information of value concerning their foreign customers. The shoe manufacturer who sends goods to Argentine, for example, finds out direct from his foreign representative just what the fashions are there and what is likely to be demanded in the coming season. That is as much a part of his business as it is to cater to the tastes of customers in Arizona or San Francisco. He would no more rely on a public institution for one class of work than for the other. In general, it appears to us, the value of such an institution as the Philadelphia Commercial Museum must be indirect rather than direct. It is and must be a museum, as its name implies, and not a commercial agency. Its exhibits are of undoubtedly great value in educating the tastes of merchants, designers and manufacturers; but whether a city should spend its taxpayers' money for such a purpose is at least open to question, especially when the city happens to be Philadelphia, which so sorely needs to spend its revenues for things that will benefit its whole population.

The preparation of standard specifications for iron and steel has been in hand for some two years, as many of our readers know, by a committee of the American Section of the International Association for Testing Materials. At the recent meeting of the Section at Niagara Falls, N. Y. (Eng. News, July 4), the committee announced the completion of the task assigned to it and presented a series of eight specifications which, after some minor revision at the meeting were ordered to be submitted to letter ballot for approval by the Section. Should this ballot result in the approval of the specifications they will then be presented to the International Association as representing fairly American practice and as expressing the ideas of American engineers for standard specifications for international use. It will necessarily be some time before international action can be secured, if at all, and in the meantime it is hoped that the proposed specifications may furnish a basis for American practice and so far as is practicable will be adopted by American engineers in their professional work. It is in this direction it seems to us that immediate activity needs to be concentrated, and it is in this direction also that the chief obstacles are likely to be met, due in a large measure to a misapprehension of the purpose and scope of the specifications for which patronage is asked. The specifications presented by the committee are essentially general specifications. It is not expected that they will answer without modification every specific purpose. On the other hand, it is believed that for the majority of ordinary purposes for which steel and iron is used they will serve excellently as they stand, and that in all instances they may be successfully used as a basal specification into which particular requirements for specific purposes can be built without either departing entirely from a standard practice or restricting the liberty of the engineer to demand particular qualities or properties of metal for particular purposes. Regarded in this common sense manner there seems to be no good reason why engineers generally may not adopt and conform to the specifications as drafted. There are several good reasons why they should do this if they can consistently so do, but the principal one, so far as the efforts of the American Section are concerned, is that it will aid materially in securing the compliance of the European Sections to an international specification agreeable to American engineers and steel makers. This is likely to be a difficult task at the best and it will be rendered much more difficult if the European members of the committee are able to retort that the specifications advanced by the American members are not honored even at home and by their own sponsors. It is the just boast of the American Section, and one of which it is deservedly proud, that it has set the pace in this important work of the International Association and has established a model which is being followed by the European Sections in their corresponding work, and it would be a poor commentary on the engineering profession in America if the Section failed to receive at home the support which would enable it to maintain its forward place and particularly the ascendency of American ideas in the matter of international specifications for iron and steel.

THE HAY STEEL PROCESS AND THE FIRST STEEL BRIDGE IN AMERICA.

The reminiscences of Gen. William Sooy Smith and others connected with the construction of the original Glasgow Bridge, which are contained in the discussion reprinted from the Journal of the Western Society of Engineers in another column of this issue will be read with unusual interest by engineers. The original Glasgow Bridge deserves for several reasons to be ranked among the notable bridges of the world. It was the first wrought steel bridge to be put under construction in America, and at the time of its completion it was the largest all-steel bridge ever erected. For American engineers at least it derives additional interest from being the most important structure which was ever built of Hay steel. General Smith was the engineer of the structure and the person chiefly responsible, probably, for the use of steel in its construction. His remarks have, therefore, the force of high authority. They tell only part of the story, however, and in some instances are, through inadvertence, open to misunderstanding.

While the information given by Gen. Smith concerning the actual method of making steel, which was practiced by Mr. Hay, is meager, his remarks set forth more clearly than anything which we have seen published elsewhere the extent of this inventor's early work and the excellent qualities of the metal which he was able to produce at a very early date in the development of steel as a structural material. It may be stated at once, however, that the steel for the Glasgow Bridge was not made in the curious "electrical furnace" devised by Mr. Hay and described by Gen. Smith in his discussion. Undisputable evidence on this point is contained in a discussion before the American Institute of Mining Engineers in February, 1879, by the late Mr. William P. Shinn, M. Am. Soc. C. E., at that time General Manager of the Edgar Thomson Steel Works. This discussion also contains other information of interest and is given in full so far as it relates to the Glasgow Bridge, as follows:

> I will here mention that the fall of the Glasgow bridge in process of erection over the Missouri River, has indicated remarkable capacity for resistance to shock on the part of the steel therein employed, which was of the variety known as "Hay" steel, manufactured by the Edgar Thomson Steel Co., Ltd., by the Bessemer process. It was at first announced that no members had been broken by the fall, but the facts as subsequently ascertained, while not quite so remarkable as this would indicate, are sufficiently so to admit of repetition here.
>
> A span of that bridge, 314 ft. in length, was so nearly completed that in six hours more it would have been self-sustaining, when the falseworks were taken out by ice and the whole structure fell into the Missouri River by buckling in the center. The height of the top chord was 102 ft. and of the bottom chord 72 ft. above the water. The total weight of steel on the falseworks was about 160 tons. Of that amount there was: Entirely uninjured, about 50 tons; requiring slight repairs, 30 tons; requiring heavy repairs, 20 tons; requiring to be renewed, 60 tons, of which latter, 20 tons consisted of eye and chord bars which were only bent. Of 213 eye-bars (rolled upon Kloman's mill), only four were broken. Careful investigation showed that there was not a single break which started from a flaw, and not a rivet broken in the whole structure, the rivets being of the same material as the rest of the structure. This is certainly a very satisfactory test of the first all-steel bridge in this country.

It will be noticed from Mr. Shinn's discussion that the metal used in the Glasgow Bridge was Hay steel, made by the Bessemer process. As Mr. Shinn also points out, it was remarkably good material, though not such steel as would be used for bridges to-day, even where hard steel is specified. Gen. Smith states in his discussion that the specifications called for steel having an ultimate strength of 80,000 lbs. per square inch with an elongation of 10 per cent. and a reduction of area of 10 per cent. Mr. W. B. Coolidge, who tested the steel for Gen. Smith, states that the contained carbon was 0.42 per cent. It is interesting to note here that in the steel made by the same process for the Kinzie St. Bridge of the Chicago & Northwestern Ry., the carbon content was brought down more nearly to the amount now contained in structural steel, but a low manganese and exceedingly high phosphorus and sulphur content accompanied this reduction, with the result that a very uncertain and treacherous material was furnished.

In connection with Mr. Shinn's reference to the method of making the eye-bars for the Glasgow Bridge, it is worthy of note that this was probably the first use of rolled steel eye-bars in an important bridge structure. In a paper describing the (then) new Kloman mill, which was read at the Richmond, Va., meeting of the American Institute of Mining Engineers in 1879, by Mr. Charles

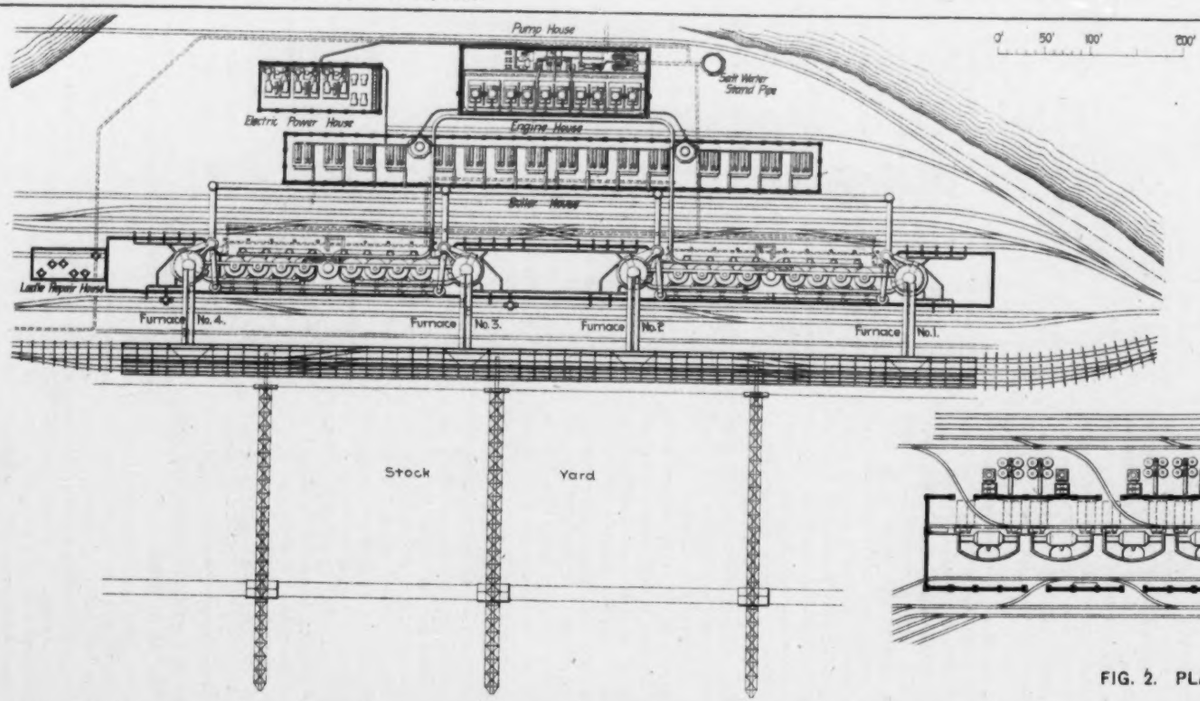

FIG. 1. PLAN OF BLAST FURNACE PLANT.

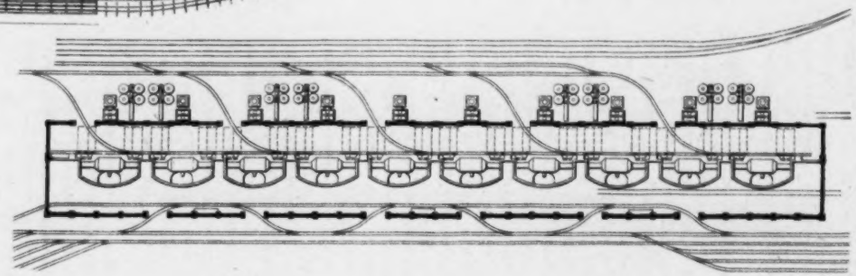

FIG. 2. PLAN OF OPEN HEARTH STEEL PLANT.

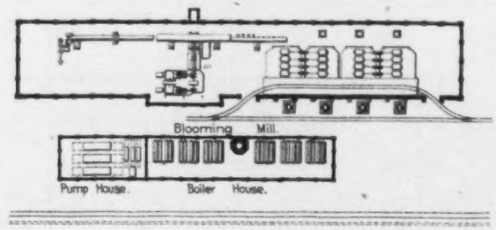

FIG. 3. PLAN OF BLOOMING MILL PLANT.

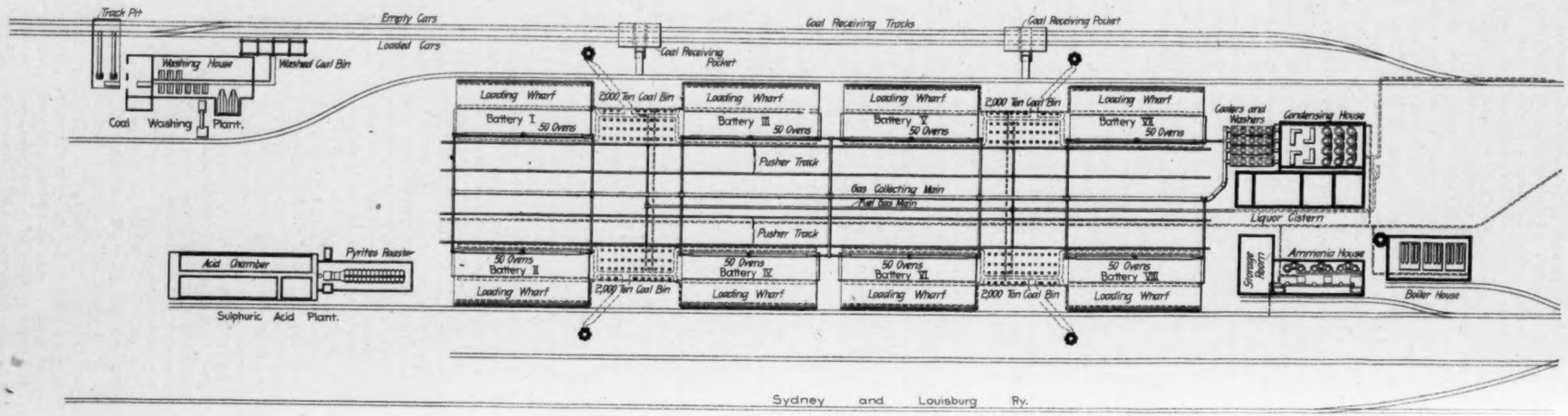

FIG. 4. PLAN OF COKE OVEN PLANT.

THE WORKS OF THE DOMINION IRON & STEEL CO., SYDNEY, CAPE BRETON.

A. J. Moxam, Assoc. M. Am. Soc. C. E.; General Manager; F. W. Waterman, Chief Engineer.

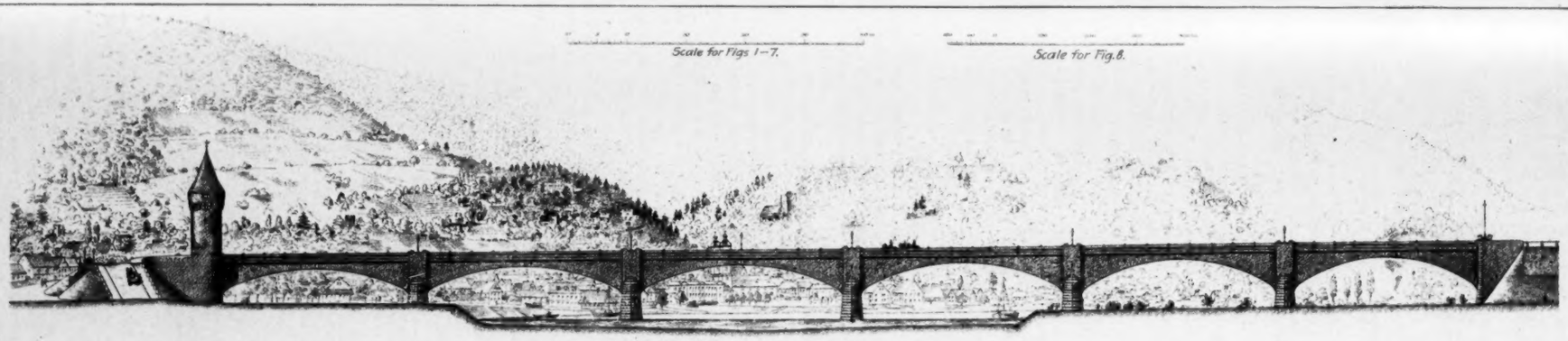

FIG. 1. SIDE ELEVATION.

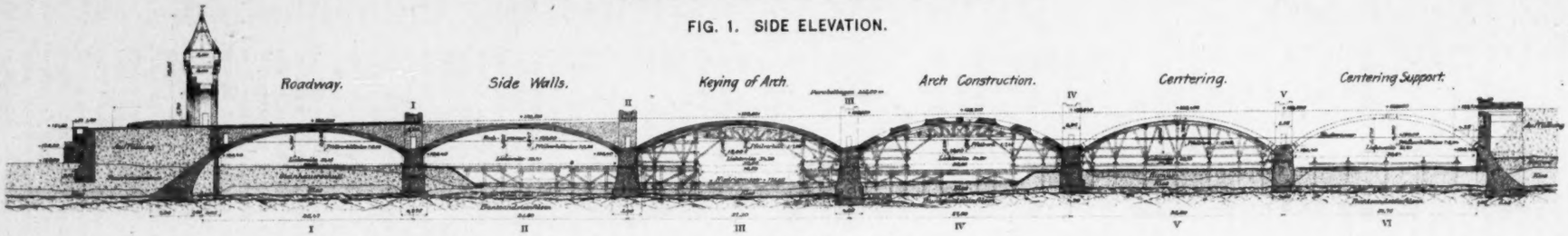

FIG. 2. LONGITUDINAL SECTION.

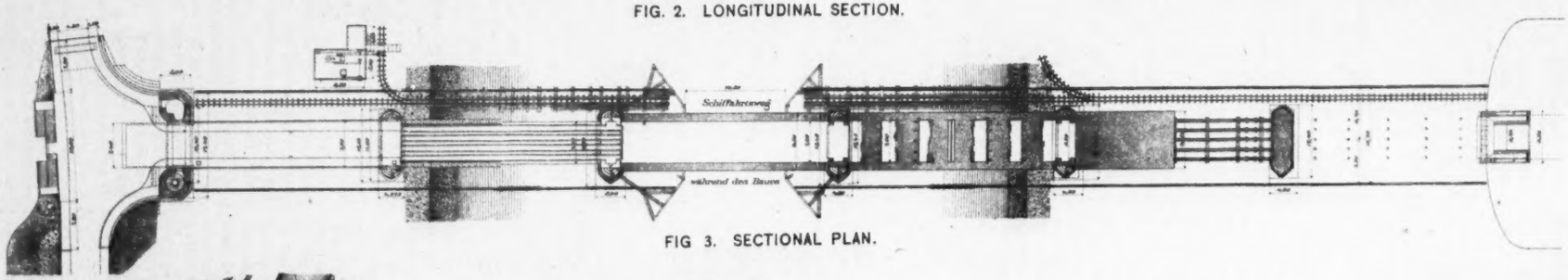

FIG 3. SECTIONAL PLAN.

FIG. 8. GENERAL PLAN.

FIG. 4. END ELEVATION SHOWING APPROACHES AT MILTENBERG END.

FIG. 5. ELEVATION OF PIER III.

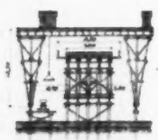

FIG. 6. CROSS-SECTION OF CENTERING SHOWING TRAVELING CRANE.

FIG. 7. CROSS SECTION OF ARCH VI SHOWING ABUTMENT.

THREE-HINGED MASONRY ARCH HIGHWAY BRIDGE OVER MAIN RIVER NEAR MILTENBERG, GERMANY.

CHAS. HART, LITH., 26 VESEY ST., N. Y.

MacDonald, M. Am. Soc. C. E., reference is made to the fact that the eye-bars for the Glasgow Bridge were rolled in this mill, with some general comment on the manufacture of eye-bars which is of curious interest at the present time, and which we extract as follows:

Wrought-iron eye-bars for bridges and roofs, designed upon what is known as the pin-connection system, have been successfully manufactured in this country for some years. The most approved methods employed have been the hydraulic upsetting process and by die forging under a steam hammer. By neither of these processes, however, has it been found possible to make uniformly good steel eye-bars; and it has been due to this fact, perhaps more than to any other, that the value of this material, manifestly so much better suited for structural purposes than iron, has not yet been fully recognized in bridge construction.

Mr. McDonald then goes on to say that this want of a process suitable for manufacturing steel eye-bars has been supplied by an invention recently perfected by Mr. Andrew Kloman, of Pittsburg, Pa.

In conclusion it is important to notice that only the five main spans of the Glasgow Bridge were built of steel, and that the approach spans and viaduct were built of wrought iron. Steel was too expensive a material at that time to use for minor construction. Gen. Smith points out in his discussion that by using steel for these main spans he was able to reduce the weight of metal required about 25 per cent. below the weight of iron, for trusses of the same dimensions. The steel structure as designed did good service, and when it became necessary to rebuild the bridge because of defective foundations the engineers of the new work were able to say: "The old steel superstructure, though light, was in good condition, and had never shown any signs of weakness" (Eng. News, March 14, 1901). Considering that in the interval between its construction and demolition the prevailing train loads which were carried by the structure had doubled this is an epitaph which the builders of the first all-steel bridge in America may well be proud of have borne by their work.

A considerable portion of the discussion presented by Gen. Smith and the speakers who followed him related to the question of precedence in date of construction between the Glasgow Bridge and other early steel bridges. So far as the relative claims made for this structure and for the Kinzie St. Bridge of the Chicago & Northwestern Ry. are concerned, this question seems to be quite fully settled by the remarks of Mr. W. H. Finley. The Glasgow Bridge was begun and partly completed before the Kinzie St. bridge was commenced, but the smaller bridge was finished about a month before the Glasgow Bridge was completed. Gen. Smith's strongly expressed belief that the Glasgow Bridge was the first steel bridge ever built will, however, hardly stand the test of evidence. In a notable series of articles by Prof. G. C. Mehrtens, published in "Zeitschrift des Vereines Deutscher Ingenieure" during 1900, interesting reference is made to what the author considers to have been the earliest uses of wrought steel in bridge building, as follows:

For construction purposes, however, above all in bridge building, open-hearth and puddled steel have been used only in a very few isolated cases, two of which have become better known: The Karl suspension bridge over the Danube Canal at Vienna, built by von Metz in 1828, with links made of open-hearth steel, which is the first known application of weld steel to bridge construction, and the Goeta-Elf bridge, near Trollhaetten, with a span of 42 m. (138 ft.), designed by Adelskoeld and finished in 1866, with girders of the fishbelly type made of puddled steel. The first instance of the application of ingot steel to constructive purposes is found in the use of Bessemer steel for shipbuilding in England in 1860-61. Almost at the same time it was tried to utilize Bessemer steel for the purpose of bridge building. The first occasion of this appears to have been when three road bridges were built in 1862 by the Dutch local boards of Bunde, Elsboo and Birgen op Zoom. According to documents supplied to the writer by Professor Krohn, these bridges consisted of braced girders of from 30 m. to 37 m. span (98 ft. to 121 ft.). Shortly after, in 1863-4, the Board of the Dutch State Railways introduced Bessemer steel into certain parts of bridges on its system, the first case being that of the Yssel bridge on the Arnheim-Leuwarden line, built in 1863-4.

Compared with the Glasgow Bridge, these Dutch Bessemer steel bridges were quite insignificant. Their success, moreover, was so indifferent as to discourage further experiments with steel as a bridge material; indeed, Prof. Mehrtens states that they were responsible for a "pronounced distrust against the use of ingot steel generally, which gradually took possession of wide engineering circles throughout Europe." The record of the Glasgow Bridge, as has already been shown, was of a far different nature. It was at the date of its completion the largest all-steel bridge which had even been built, and it established the success of steel as a structural material for bridges, although this last fact was not realized until many years afterward. In view of these facts, Gen. Smith and American engineers generally need have no regrets that they were not the very first to build an all-steel bridge.

THE PROPOSED SYDNEY HARBOR BRIDGE, SYDNEY, NEW SOUTH WALES.

As is noted in our advertising columns, designs and bids for construction are asked by the government of New South Wales for a bridge to connect the towns of Sydney and North Sydney, with a clear span of 1,200 ft., over Sydney Harbor. In the length of its main span this bridge is exceeded by only five bridges now completed or under construction anywhere in the world, and in capacity and other general dimensions it ranks correspondingly high among bridge structures. Since the St. Lawrence River bridges at Montreal and at Quebec, Canada, no bridge of equal importance and of equally fair prospects for early construction has been submitted to open competition for complete detail designs and tenders for construction. It is fair to presume from all this that the competition will be active among engineers and bridge building firms the world over, and in view of the freedom permitted the competitors in general design as well as in details of construction this competition should nowhere be more active or more likely to result successfully than among

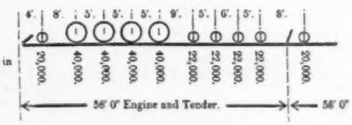

Diagram of Locomotive Load Assumed in Calculating Strains in Sydney Harbor Bridge.

American engineers and bridge builders. For these reasons a somewhat more extended account of the proposed work and of the conditions under which it must be carried out will be of interest. For the information from which this account is prepared we are indebted to the printed "conditions" of the competition furnished us by Mr. J. Davis, M. Inst. C. E., Chairman Sydney Harbor Bridge Advisory Board, Sydney, New South Wales.

GENERAL DESCRIPTION.—The tenders are asked for the manufacture, construction and entire completion of a bridge and approaches 3,000 ft. long, measured between centers of end piers, and embracing a main span across the harbor, necessary approach spans and intermediate and end piers. The bridge is to have a clear headway of 170 ft. for 600 ft. at the center of the main span and of not less than 150 ft. for the remainder of the main span, which must be of such a length that the clear waterway between piers shall be at least 1,200 ft. The maximum grades allowed will be 1 in 50 for railway and 1 in 30 for roadway traffic. The bridge is to provide for a double track railway of standard gage, two 30-ft. or one 60-ft. roadway with double tramway tracks, and two sidewalks 12 ft. wide each. The floor construction is required to be coke-concrete over buckle-plates or troughing, concrete, steel-concrete or other approved construction as selected by the contractor, with hardwood crossties to carry the railway rails, wood block paving for the roadways and sheet asphalt for the sidewalks. Wherever pneumatic caisson work, cofferdams or other foundation processes permit, the foundations are to be carried to solid rock, and where it is impracticable to reach solid rock by these recognized processes the bidder is required to state definitely in detail the process he proposes to employ. In case a suspension bridge is designed, the indications are that for some distance back from both shores the bed rock is suitable for anchorage foundations, it being a compact limestone, but one of a somewhat jointy nature. The bidder must provide for an elevator capable of carrying 20 persons to give access from the roadway to the top of the tower or cantilever on the Sydney side, where an observation platform to accommodate 50 persons is to be provided.

LOADS.—The dead loads are to be estimated according to a schedule of weights adopted by the board, in which the weight of the principal material, steel, is given as 489 lbs. per cu. ft. The live loads to be assumed are briefly as follows: For footways, 100 lbs. per sq. ft. For railway stringers, two 268,000-lb. coupled engines with wheelbases and wheel loads, as shown by the accompanying diagram, must be assumed; and for roadways, 100 lbs. per sq. ft. or a rolling load of 44,800 lbs. on four wheels spaced 10 ft. apart longitudinally and 5 ft. apart transversely. For main cross girders the load to be assumed will be two coupled locomotives combined with the live load for roadways. For main trusses, cables, stiffening trusses and trusses of approach spans as the combination may be the live load assumed shall be one rapidly-moving train 538 ft. long on each track, weighing 4,000 lbs. per foot, exclusive of locomotives, preceded by two coupled engines of the type specified; or a total train length of 650 ft. and a total train load of 1,200 tons on each track. These trains are to be assumed to be placed two abreast, or moving in opposite directions, at such positions as will give the worst possible stresses for the cables and stiffening trusses of suspension bridges and for all members of the main trusses of cantilever bridges. In addition to the above train loads, there must be assumed a live load of 100 lbs. per sq. ft. on the two roadways and footways, either distributed over the whole structure, or moving uniformly from end to end of the main structure, such load to be taken as extending over the whole surface of the two roadways between curbs and over all portions of the two footways which are available for foot passengers. The wind pressure is to be assumed as acting at right angles to the bridge and as being 50 lbs. per sq. ft. of exposed surface treated as a uniform load over the whole structure for the bridge unloaded, and as being for the bridge loaded, 30 lbs. per sq. ft. of exposed surface treated as a uniform load over the whole structure, together with 300 lbs. per lin. ft. over the whole length of the bridge, acting at 8 ft. 6 ins. above the rail and treated as a moving load. The wind pressure on the main span is to be calculated from the details of the design submitted, on the general principle that the area of exposed surface will be equal to the area of one main truss multiplied by two, plus the area of the handrail multiplied by two, plus the area of the deck system multiplied by 1.5, the area in each case to be taken as the area seen in elevation, at right angles to the direction of the wind. For the wind pressure on the main towers of a suspension bridge, the exposed surface is to be taken equal to the area multiplied by two for each pair of bents. A range of 60° F. on each side of mean temperature is to be allowed for. The coefficient of expansion of steel for 60° F. is to be taken as 0.0004. All portions of the structure are to be designed to resist the longitudinal stresses induced by suddenly stopping one or both of the maximum trains specified, the coefficient of friction of the wheels on the rails being assumed as 0.2. Such portions of the structure as are on a curve are to be designed to resist the centrifugal force due to one of the maximum trains specified on each track. Except in the case of the main towers and main trusses of cantilever bridges, and the main towers, cables and stiffening trusses of suspension bridges, an addition for impact is to be made to the stresses due to live loads which is to be determined by the following formula:

$$I = C \times \left(L \times \frac{L}{L \times D} \right).$$

In this formula D = calculated dead load stress in member; L = calculated live load stress in member; I = addition to be made for impact to maximum live load, including train momentum and centrifugal force, and C = a constant, representing 75% for all train loads, 30% for the rolling load of 20 tons specified for the roadways; and

free from dirt or quarry refuse, and to be washed with clean water if necessary. Rubble concrete to be mixed in a similar manner, and to consist of the same materials, in the same proportions as ordinary concrete, with uncoursed rubble blocks of clean, hard sandstone, not less than 1 cu. ft. embedded therein, with at least 4 ins. of concrete between each block in every direction, no portion of any block to come within 12 ins. of the top, bottom, or other edge of hearting; blocks to be bedded thoroughly in the fresh concrete, and all concrete around blocks to be well rammed.

Coke concrete for the deck of bridge to be mixed in the same manner as ordinary concrete above, but to consist as follows: Four measures of coke, broken to pass through a 1¼-in. ring, but caught on a sieve of ⅝-in. mesh; two measures of coke grit screened through a sieve of ⅜-in. mesh, but caught on a sieve of 1/80-in. mesh; and one measure of cement. Coke to be of the best quality, clean, hard, free from dust and dirt, washed clean if necessary, and thoroughly saturated with water before mixing. After the coke concrete has been laid on the deck of the bridge, the surface must be kept moist with damp bags until it has thoroughly set; the surface to be then well brushed with cement grout, and rendered to the proper level and convexity with cement mortar in one layer, not less than 1-in. thick on carriageway nor ⅝-in. thick on the footways. Rendering to have a uniform surface, and must have set at least seven days before wood blocking or asphalting is commenced, up till which time it shall be kept moist with damp bags.

The piers to be built of quarry-faced ashlar masonry facing, set in cement mortar, and backed with concrete. Bluestone, trachyte, or granite ashlar to be used for facing the harbor piers from 1 ft. below low-water mark to top of pier. Sandstone ashlar to be used for facing the piers on land; stone to be equal to the best sandstone from the Pyrmont Quarries, Sydney.

from the Bell Island iron mines, which are operated by the Dominion Iron & Steel Co. The land which the works occupy was expropriated by the town of Sydney, and presented to the company. Its area is about 800 acres.

The works proper consist, in general, of a plant of four blast furnaces; ten 50-ton open-hearth furnaces; a 35-in. blooming mill and pit furnaces; 400 Otto-Hoffman coke ovens; coal washing and sulphuric plants, and essential by-product plants. In addition there are a large machine shop and foundry capable of taking care of all mill and furnace work. In connection with these works there is about 20 miles of railway track, full ore-handling equipment, receiving and shipping piers, and all the necessary attributes to a well-equipped modern steel plant.

ORE AND LIMESTONE SUPPLY.

The Bell Island mines are equipped with conveyors, steam shovel, bins and pockets of sufficient capacity for the mining of 8,000 tons of ore per day when required. The loading pier at Bell Island is in deep water which enables the largest cargo vessels to load at all times. The pockets hold a large ore supply and boats of 8,000 tons capacity can be loaded in about five hours.

factured by the Worthington Co., of Brooklyn, N. Y., and are two in number, of a capacity of 3,000,000 gallons each per 24 hours. The estimated requirements of the works for fresh water is about 3,000,000 gallons per day. These are duplex, direct-connected, triple expansion, condensing, pumping engines, with high pressure cylinder 12 ins. diameter; intermediate cylinder 19 ins. in diameter; low pressure cylinder 30 ins. in diameter; and plunger 16 ins. in diameter, all with 24 ins. stroke.

The pump house is provided with a large well to which the water is admitted through an intake pipe, constructed of cypress wood, leading from a crib provided with screens and located at the center of the river. This supply is abundant and the water is of an excellent quality. About 600 ft. of the main line is of 36-in. pipe and the balance to the works along the roadway and through the company's property is 24 ins. in diameter; all being cast-iron bell and spigot pipe of the ordinary waterworks specifications. Connections have been provided for the town of Sydney and other consumers. In case of additional water supply being required, a stand-pipe 20 ft. in diamter and 85 ft. high is located on the water

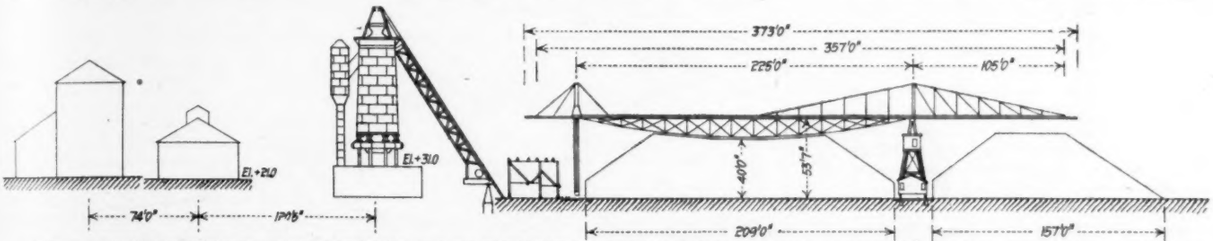

FIG. 5. TRANSVERSE SECTION THROUGH BLAST FURNACE PLANT AND STOCK YARDS; DOMINION IRON & STEEL CO., SYDNEY, CAPE BRETON.

The requirements in respect to workmanship do not differ materially from those for first-class bridge work generally. There is an extended list of general conditions which are to govern the work, including rigid requirements as to the hours of labor required and the rates of wages to be paid. Perhaps the most unusual requirement is the following:

> The contractor shall maintain the works for a period of twelve months after the engineer shall have certified that the works have been finally completed, or after the taking into use of the works by the government, which ever of these events shall be later in point of time; and if any part should within that period show signs of weakness, or of giving way, or if any defective workmanship or materials be detected, the contractor, when called upon to do so, shall make good the same at his own expense, to the satisfaction of the engineer, before any moneys held by the government on account of this contract will be paid. The government shall have the full, free and unrestricted use of the said works, without any interference whatever on the part of the contractor during the currency of this period of maintenance; and such use of the said works on the part of the government shall not be held as relieving the contractor of any liabilities or obligations whatever in respect of this contract.

THE WORKS OF THE DOMINION IRON & STEEL CO. AT SYDNEY, CAPE BRETON.

(With full-page plate.)

As many of our readers will recall, one of the places of chief interest visited by the members of the American Institute of Mining Engineers during their excursion through the maritime provinces of Canada in August of 1900 was the new works of the Dominion Iron & Steel Co., then in process of construction at Sydney, Cape Breton. Owing to the uncompleted condition of the work specific details of this interesting plant were not then available (Eng. News, Sept. 7 and 13, 1900). Since then the plant has been put in operation and we have been furnished by Mr. A. J. Moxam, Assoc. Am. Soc. C. E., the General Manager, with drawings and information from which the following description and illustrations have been prepared.

LOCATION OF WORKS.

The works of the Dominion Iron & Steel Co. are located on the harbor of Sydney, Cape Breton, Nova Scotia, in close proximity to the Cape Breton coal fields, operated by the Dominion Coal Co., Ltd.; 80 miles from the extensive limestone quarries at Marble Mountain, and about 400 miles

The Marble Mountain limestone quarries are located at Clark's Cove, on West Bay of the Great Bras d'Or lakes. The quarry is at an elevation of about 300 ft. above the level of the lake, and the deposit, which is a true marble, is of an especially good quality. From the quarry the stone is lowered to a crusher by a double skip car system with drum at top, the loaded car hoisting the empty. The crushed stone is fed by gravity to a 24-in. conveying belt which carries it to an open bin at the foot of the mountain. Underneath the bin chutes there is arranged a 30-in. conveying belt, of a capacity of about 600 tons per hour, which carries the crushed stone to an inclined belt, leading directly to the loading pier. This also has a capacity of 600 tons per hour, and the barges or vessels for transportation can be loaded in from three to five hours.

In addition to this marble quarry the company has developed a dolomite quarry at Georges River, about 14 miles from the works at Sidney. This quarry has the capacity of about 1,200 tons per day.

WATER SUPPLY.

The fresh water supply for the works is obtained from Sidney River, which is about five miles from the location of the works. A dam and pumping station have been constructed on this river for separating the fresh from the salt water, and the drainage from an area of 65 square miles is available for service. The dam is about 240 ft. long and has a depth of 20 ft. at the center of the stream. It is constructed of cribbing filled with stone; the salt water side is planked with creosoted timber, and the fresh water side is sealed by the means of a puddle face and gravel slope. The dam is provided with a fishway, and the company has constructed a lock which allows a boat 20 ft. wide and 50 ft. long with 6 ft. draft at low water, to pass through during the open season of navigation.

The pumping station is constructed of brick and is equipped with two horizontal tubular boilers of capacity of about 110 HP. each. These are strongly built and especially designed for a working pressure of about 150 lbs. per sq. in. They were built by T. A. McLean, Charlottetown, Prince Edward Island. The pumps were manu-

main inside the works. Salt water will be used for the blast furnace circulating system.

ORE AND STOCK HANDLING PLANT.

The ore handling plant consists of a pier, upon which will be located four hoisting machines or towers of a type similar to those used on the Montreal docks for handling coal (Eng. News, May 30, 1901). These towers have given very satisfactory results, and are a quick machine for the handling of all heavy materials. The capacity of each tower is from 1,250 to 1,500 tons per 24 hours. These were designed and built by the Dominion Bridge Co., of Montreal. The machines are mounted on trestle work, upon which is provided a double track system for handling cars. The ore is unloaded directly from the boats to shallow bins, or hoppers, which form part of the mechanism, and is delivered through these to hopper bottom cars. The trestle track leads from the pier about 1,100 ft. to the ore bins, which are provided with three tracks with suitable cross-overs for the handling of coke, ore and limestone for the regular furnace supply, and for storage in the stock yard. The stock yard is provided with three Brown Hoisting & Conveying Machine Co.'s traveling machines similar to those used at the Duquesne furnaces of the Carnegie Co., and of the cross-section shown herewith. These machines have ample capacity for taking care of the storage of six months' supply of material as well as for re-handling the stock for the winter operation of the blast furnaces.

The stock yard has an effective width of 366 ft., and is 952 ft. long with tracks for an extension of 150 ft., making the available length of the cross-section shown about 1,100 ft. This yard is of a capacity sufficient to take care of six months' supply of ore and limestone for four blast furnaces. The ore is brought in from the pier upon which the unloading machines are located, in the before described manner, and transported to the top of the bins, whence it is dropped into the stock or storage bin, the former delivering its supply to a motor-driven scale car underneath, which transfers the stock to the skip cars, which deliver it to transfer cars upon which are placed two 3-ton buckets, which are handled by the Brown machine, the stock being lifted and de-

15% for the live load of 100 lbs. per sq. ft. on the roadways and footways.

The preceding general description and conditions of loading have been considerably condensed from the printed conditions. We reprint the requirements for unit stresses and for material more nearly in full, as follows:

UNIT STRESSES.—All portions of the structure shall be so proportioned that the maximum loads shall not cause the stresses to exceed the following, for medium steel (where not otherwise specified):

In tension, (a) dead load and live load, on all members, including train momentum, centrifugal force, and impact, where specified, P = 17,000 lbs. per sq. in. on net section; (b) temperature and wind pressure on all members, P = 24,000 lbs. per sq. in. on net section; (c) in the following members no addition is to be made for impact to the live-load stresses. These members are to be proportioned, both for dead-load and live-load stresses, upon the following maximum unit stresses: Floor-beam hangers and other similar members liable to sudden loading (bars with forged ends): For loads due to railway—P = 7,000 lbs. per sq. in. on net section. For loads due to roadways or footways—P = 9,000 lbs. per sq. in. on net section. Floor beam hangers and other similar members liable to sudden loading (plates and shapes): For loads due to railway—P = 6,000 lbs. per sq in. on net section. For loads due to roadways or footways—P = 8,000 lbs. per sq. in. on net section. In determining net sections, all rivet holes are to be taken as ⅛-in. larger than the nominal diameter of the rivet.

In compression, (a) dead load and live load, on all members, including train momentum, centrifugal force, and impact, where specified, $P = 17{,}000 - 80\frac{l}{r}$ lb. per sq. in. on gross section; (b) temperature and wind pressure on all members, $P = 22{,}500 - 100\frac{l}{r}$ lb. per sq. in. on gross section. Where P = working stress per square inch; l = length of member in inches, center to center of connections; r = least radius of gyration of the section in inches. No compression member shall have a length exceeding 100 times its least radius of gyration, except for the windbracing, where the length may be 125 times the least radius of gyration.

For all members subjected to stresses alternating between tension and compression, no addition shall be made for impact to the live-load stresses; but the sectional areas provided shall be proportioned upon the following unit stresses: (a) All members, other than stiffening trusses of suspension bridges: For loads due to railway:

$$\text{Tension } P = 12{,}000\left(1 - \frac{1}{2}\cdot\frac{\text{minimum}}{\text{maximum}}\right) \text{ per sq. in. on net section.}$$

$$\text{Compression } P = \left(12{,}000 - 50\frac{l}{r}\right)\left(1 - \frac{1}{2}\cdot\frac{\text{minimum}}{\text{maximum}}\right) \text{ per sq. in. gross section.}$$

For loads due to roadways and footways—

$$\text{Tension } P = 15{,}000\left(1 - \frac{1}{2}\cdot\frac{\text{minimum}}{\text{maximum}}\right) \text{ per sq. in. on net section.}$$

$$\text{Compression } P = \left(15{,}000 - 60\frac{l}{r}\right)\left(1 - \frac{1}{2}\cdot\frac{\text{minimum}}{\text{maximum}}\right) \text{ per sq. in. on gross section.}$$

In applying the above, the resultant stresses shall be calculated for the member under consideration due to the sum of the dead-load stress and the live-load stress of the like sign, and also to the difference of the dead-load stress and the live-load stress of the opposite sign. The "minimum" stress shall then be taken to be the less and the "maximum" stress the greater of the resultant stresses so obtained. (b) Stiffening trusses of suspension bridges

Tension P = 14,000 lbs. per sq. in. on net section.

Compression $P = 14{,}000 - 60\frac{l}{r}$ lbs. per sq. in. on gross section. The greater of the two sectional areas required as so determined to be used in proportioning the members both for (a) and (b).

In the case of members subjected to a bending stress in addition to a direct tensile or compressive stress, the extreme fiber stress due to a combination of the bending and direct stresses shall not exceed the limits specified for direct stress.

After making the specified allowance for impact, the shearing stress on pins, bolts, and machine-driven rivets shall not exceed the following:

Medium steel	12,000 lbs. per sq. in.
Wrought iron	9,000 lbs. per sq. in.

For field rivets, hand driven, the number of rivets determined as above shall be increased 30%.

After making the specified allowance for impact, the pressure upon the bearing surface (diameter × thickness) of pin, bolt, or machine-driven rivet holes shall not exceed the following:

Medium steel	24,000 lbs. per sq. in.
Wrought iron	16,000 lbs. per sq. in.

For field rivets, hand driven, the number of rivets, as determined above, shall be increased 30%.

After making the specified allowance for impact, the stresses upon the extreme fibers of pins due to bending shall not exceed 25,000 lbs. per sq. in., providing that the bending moment in the pin is calculated upon the assumption that the pressure from each member is distributed evenly over the bearing surface of such member.

No portion of the web-plate shall be included when proportioning the flanges of plate girders. The webs of plate girders must be stiffened at intervals about the depth of the girders, whenever the shearing stress per sq. in. exceeds the stress allowed by the following formula:

$$\text{Allowing shearing stress} = \frac{C}{1 + \frac{H^2}{3000}}.$$

Where C = 12,000 for girders in which the maximum stress is due to load of railway, and 15,000 where the maximum stress is due to load of roadways or footways; H = ratio of depth of web to thickness. No web-plates shall be less than ⅜-in. thick in railway girders, nor less than 5/16-in. thick in roadway or footway girders. The stiffeners shall be a neat and close fit under the flanges of the girders.

After making the specified allowance for impact, and deducting for rivet holes, all rolled girders shall be proportioned by their moment of inertia, allowing such value for the modulus of rupture that the unit stresses on the extreme fibers shall not exceed the limiting values specified.

The depth of all members shall be such as to prevent undue deflection under the maximum loads specified.

In all expansion bearings turned rollers are to be provided, working between planed surfaces, nowhere less than 6 ins. in diameter, and so proportioned that the pressure per lineal inch of roller shall not exceed 300 d for steel rollers between steel surfaces, where d is the diameter of roller in inches; such pressure not to exceed 3,000 lbs. per lin. in. In the case of long rollers, great care is to be taken that the saddles and bedplates are made sufficiently deep and stiff to ensure an equal distribution of the load over the whole length of the roller.

The main cables and suspenders of suspension bridges are to be proportioned for the maximum loads specified, with a factor of safety of 3½ on the minimum ultimate strength of the material proposed to be used by the tenderer.

The maximum pressure upon any portion of the masonry or concrete in the piers shall not exceed the following:

	Per sq. in.
Trachyte, granite or Melbourne bluestone bedstones	500 lbs.
Masonry of selected sandstone	250 "
Concrete as specified	200 "

The maximum pressure on the standstone upon which the piers are to be founded shall not exceed 25,000 lbs. per sq. ft. under the maximum loading specified. Such pressure to be the actual pressure upon the foundations due to the weight of the structure and loads thereon, without making any allowance for the weight of the water or material at present overlying the rock, or for skin friction on the sides of the pier.

MATERIALS OF CONSTRUCTION.—Steel castings may be made by the open-hearth or Bessemer process. All the important castings to be of steel; castings to be sound, true, free from blow holes, flaws, and other defects, carefully made and thoroughly annealed. Test specimens cut from coupons on the annealed castings to give the following results:

Tensile strength in lbs. per sq. in.	60,000 to 70,000	
Yield point in lbs. per sq. in., not less than 50% of ultimate strength from test.		
Elongation in 2 ins., not less than, %	22 to	18
Contraction of area, not less than, %	30 to	25
To bend cold without fracture around 1 in. diameter, degrees	120 to	90

Each melt to be tested for tension and bending; bending specimens to be 1 in. wide and ½-in. thick, and the tests made by pressure or by blows; the specimens for bending tests to be planed or milled on edges.

Whatever type of bridge is submitted, the whole of the material in the deck system, anchor bars, tie rods, and all built structural work, excepting cables, in the superstructure and towers (if any) is to be of medium steel. The steel to be made in an open-hearth furnace, and must not contain more than .06% of sulphur, nor more than .08% of phosphorous; the analysis to be made on drillings taken from a small test ingot. Test specimens taken from the finished material of each melt, and of the same thickness as the plate or bars from which they were taken, to give the following results:

Tensile strength in lbs., per sq. in.	60,000 to 70,000
Yield point in lbs., per sq. in., not less than 50% of ultimate strength from test.	
Elongation in 8 ins., not less than, %	20

Full-sized eye-bars to have a tensile strength of not less than 55,000 lbs. per sq. in., and to give an elongation of 12½% in 15 ft. of the body of the eye-bar. Eye-bars to break preferably in the body of the bar; but if the specified tensile strength and elongation are obtained, the eye-bars will not be rejected if not more than 25% of those tested; at or above a red heat, 180° flat on itself; and when around a diameter equal to the thickness of the specimen tested; at or above a red heat, 180° flat on itself; and when quenched in water at a temperature of 80° F., after having been heated to a dull cherry red, 180° around three times the thickness of the specimen—without showing any sign of injury or fracture. Test specimens to be taken from the finished material of each melt as it comes from the rolls, and tests made by pressure or blows; the specimens for bending tests to be planed or milled on edges.

Rivet steel is to be made in an open-hearth furnace, and must not contain more than .04% of sulphur, nor more than 0.8% of phosphorous; the analyses to be made on drillings taken from a small test ingot. Test specimens from the finished material of each melt to give the following results:

Tensile strength in lbs. per sq. in.	50,000 to 60,000
Yield point in lbs., per sq. in., not less than 50% of ultimate strength from test.	
Elongation in 8 ins., not less than, %	26

The rivet steel must bend cold 180°, flat on itself, without fracture on the outside of the bent portion, and rivet rods tested to be of the full size as rolled.

Wrought iron may be used for the handrails, fenderplates, bolts, washers and similar minor portions not subjected to stress, also the caissons (if any) for the piers. Specimens cut from any plate, shape, or round bar to give the following results:

	Plates and shapes.	Round bars.
Tensile strength in lbs., per sq. in.	48,000	51,000
Yield point in lbs. per sq. in., not less than	25,000	25,000
Elongation in 8 ins., not less than, %	12	15

The wrought iron must bend cold through 90° without fracture, with inner radius not exceeding three times the thickness of the specimen for plate and shape iron, nor twice that thickness for bar iron. Rivet iron must bend cold 180° flat on itself without any sign of fracture on the convex side.

Cast iron may be used for minor castings not subjected to heavy pressure. Castings to be of the best grey cast iron, as hard as can be worked, sound, true, and perfectly free from blow holes, flaws, and other defects. A blow from a hammer must produce an indentation on the rectangular edge of the casting without flaking the metal. Test bars, cast vertically from each melt, 2 ins. × [illegible] in. 3 ft. 6 ins. long, and tested on edge in cross [illegible] on 3-ft. centers, must withstand a load of 2,650 lbs. applied at the center, and give a deflection of not less than [illegible] in. before fracture.

The main cables (if any) should preferably be constructed each of a number of separate parallel wires gathered and clamped together into a compact cable. In case the wire for cables must satisfy the following requirements: Minimum tensile strength, 200,000 lbs. per sq. in.; elongation in 8 ins., not less than 5%; [illegible] in 60 ins., not less than 2½%.

The wire must be capable of being coiled cold around a rod of its own diameter without cracking. All wire to be bright, of size about No. 8, Birmingham wire gage, not straightened by machine, but drawn absolutely straight and free from any tendency to coil when unrolled from the drums. It shall be made in lengths of not less than 4,000 ft., and shipped to the site on drums of such diameter as not to cause any tendency to coil. All the wires of each cable strand must be spliced so as to form one continuous wire, the splices being so made as to have a strength of at least 95% of the strength of the wire. Details of the method proposed for splicing the wires are to be supplied by the tenderer. Cables, when made of separate parallel wires as above, must, when erected, be wrapped with wire or covered with thin steel plates, or be thoroughly protected in some other manner, particulars of which are to be given by tenderer. If the suspenders proposed by tenderer consist of wire ropes, the wire is to conform to the requirements specified above. Full details are to be supplied by the tenderer of the method of adjustment proposed for the suspenders.

Sand to be clean, sharp, hard, and free from foreign matter, and washed when necessary with clean fresh water, until the effluent water runs off clear.

The cement must be the best Portland cement, of approved brand, delivered in thoroughly sound condition, fit for immediate use, packed in strongly-made casks. Each cask shall contain not less than 374 lbs. weight of cement exclusive of packing, otherwise the deficiency must be made up in quantity. The specific gravity to be not less than 3.00. The cement must be ground so fine that the residue on a sieve of 14,400 meshes per sq. in., without rubbing, shall not exceed 15%, and on a sieve of 32,400 meshes, not more than 30%. The cement, when gaged with water to a stiff paste, must set in a damp atmosphere, in from one and a half to twelve hours. Neat cement of the consistency above mentioned will be made into pats, kept in moist air until set, and then placed in water at a temperature of between 65° and 75° F., and also in Deval's hot bath at a temperature of 180° F. These test pats will be examined from day to day, and should they show symptoms of blowing, or any alteration or variation in form or volume, or imperfect setting capacity, the whole parcel from which the cement was taken may be rejected. Notwithstanding that the cement may have set within the limit of time specified above, such cement may be rejected, if the nature of the work on which it is proposed to be used, requires a cement setting either slower or faster, as the case may be. For tensile strength, the cement will be gaged with three times its weight of standard sand (viz., sand from Nepean River, washed, dried, and sifted through a sieve of 400, and retained upon one of 900 meshes to the sq. in.), mixed with clean water, and made into briquettes formed in molds of 1-in. sectional area at the smallest part. Such briquettes to be kept thoroughly damp, and put into water 24 hours after they have been made, and remain in water at a temperature of between 65° and 75° F. until their tensile strength is tested. These briquettes must bear a tensile stress of not less than 130 lbs. per sq. in. seven days after gaging, and 200 lbs. per sq. in. 28 days after gaging. Cement when tested neat under the same conditions must bear a tensile stress of not less than 350 lbs. per sq. in. three days after gaging, 450 lbs. seven days after gaging, and 550 lbs. 28 days after gaging. Briquettes shall also, after being kept thoroughly damp for 24 hours, be kept in water at a temperature of 180° F. for seven days, when the tensile strength must be equal to that specified for 28 days at normal temperature. The tensile strength will be ascertained with the load increasing at the rate of 200 lbs. per minute, and the average breaking weight of six briquettes will be taken for each test. Any cement which absorbs in proportion more than two milligrammes of carbonic acid to three grammes of cement, shall be taken as containing more than the permissible quantity of free lime. Should the sample fail in any or all of these tests, or not show a proper progressive increase in strength with age of briquette, then the whole parcel from which the sample was taken will be rejected, and must be at once removed from the bridge site, and all expenses and loss, in freight, storing, handling, and removing such rejected cement, must be borne by the tenderer.

Grout to be mixed fluid in tubs close to where required, and used fresh, and to be composed of one part of Portland cement and one part of sand, mixed with clean cold water.

All mortar to be composed of one part of Portland cement and two parts of sand, by measurement; the cement and sand to be first mixed in a dry state, and then mixed with clean cold water, well incorporated, and used fresh. All mortar to be mixed on sawn timber platforms close to where it is required.

The composition of the concrete between the inner and outer shells of the caissons, of the concrete used to seal the bottom of the caissons either in the wet or under air pressure, and of any special concrete, such as bag concrete, which may be required, must be specified definitely by the tenderer. The ordinary concrete specified below may be used for the footings of piers, founded in the dry in the open air, also as backing for masonry-faced piers or less over all width than 15 ft. Rubble concrete may be used as backing for masonry-faced piers over 15 ft. wide, also as a hearting for the caissons after they have been sealed and pumped dry. Ordinary concrete to consist of one measure of Portland cement, two measures of sand, and five measures of approved stone, not sandstone, broken to a strict 2½-in. gage. The cement and sand to be well mixed together, and then carefully and evenly mixed with the stone on a timber platform; clean cold water to be added, and the whole turned over three times or more, until the concrete is well incorporated and ready for use before it leaves the platform; the final incorporation of the mixed materials may be done by machine. The concrete is to be used fresh in layers not more than 12 ins. thick; each layer to be properly levelled and well rammed, and if allowed to set, to be picked up and run over with cement grout before any more concrete is used. The stone to be broken by hand or crushing machine, to pass freely with its largest dimensions through a ring 2¼ ins. in diameter, and to be screened through a sieve of ¼-in. mesh; to be

brought in tank cars from the coke oven plant to storage tanks, and pumped into tank steamers.

COKE OVEN PLANT.

The coke oven plant, which is being erected under contract with the United Coke & Gas Co., is in general duplicate of the works which were erected for Mr. H. M. Whitney, President of the company, at Everett, Mass. They consist of two rows of four batteries, each consisting of 50 ovens or a total of 400 ovens. These are of the Otto-Hoffman by-product type, and the capacity is rated at 1,600 tons of coke per day. The plant consists of the necessary mechanism for the charging of coal and the pushing of coke from the ovens to a quenching floor or loading platform. These ovens are of the latest type and embody a number of changes in detail, from which the Dominion Iron & Steel Co., receive the benefit of experience of former plants of this type. In addition to eight batteries they are provided with a condenser house 60 × 100 ft., with a cistern adjoining 40 × 150 ft., and the necessary coolers, sieve washers, etc., for cooling and cleansing the gas. There is also a boiler house containing 1,500 HP. of water tube boilers, enclosed in a brick building 50 × 100 ft. Adjacent to this is the ammonia house, 40 ft. span by 106 ft. long, with adequate storing space. Adjacent to the coke oven plant, as shown on plan, is the coal washing apparatus, which is enclosed in a building 50 x 150 ft., and is provided with the necessary raw coal bins, crushers, and washed coal bins for delivery to the ovens.

The machinery and plant are practically of the design made by Stein & Boericke, of Primos, Pa., who have successfully washed by the jig system coal of the class which is furnished by the Dominion Coal Co. The capacity of the plant will be 2,400 tons per day. The sulphuric acid plant is designed under the supervision of Chas. A. Bartsch, Consulting Chemist, of Philadelphia, Pa., and has a capacity of 40 tons of acid per day. It is equipped with the latest improved apparatus and is a modification of the old chamber system. Pyrites will be used in the manufacture of this sulphuric acid, an adequate supply of which will come from the pyrites mines in Newfoundland. The plant is arranged for economical handling, and the sulphuric acid will be transferred from the storage chambers to the ammonia house in a tank car.

The machine shop, foundry, blachsmith shop, pattern and carpenter shops, are located as shown on the general plan. The machine shop is 52 ft. span, with a 20-ft. lean-to on each side, and is 256 ft. long, with a fire wall at the end. There is a cleaning room of the same cross-section as the main building between the machine shop and foundry. The shops are equipped with large and small lathes, planers and improved working tools for the handling of all mill and furnace work. At one end of the machine shop is located a locomotive pit. The machine shop erecting floor is commanded by a 25-ton electric overhead traveling crane, built by the Niles Tool Works. The foundry is of the same cross-section as the machine shop, and is 192 ft. long. It contains two cupolas of a capacity about 20 tons per hour. There is a three-pit brass foundry, and the necessary blowers, hoists and equipment for mill and foundry. For serving the floor, there are two electric overhead traveling cranes, one 25-ton was built by the Niles Tools Works, and one of the same capacity with auxiliary hoist was built by the Dominion Bridge Co., Montreal. The boiler room contains an air compressor for furnishing power to the chipping and hoisting tools, and two boilers of 125 HP. each. These are of the Babcock & Wilcox type water tube.

The blacksmith shop is equipped with bolt header, steam hammer and ordinary tools. The building covering this part of the outfit is 52 ft. 4 ins. span and 192 ft. long.

The pattern shop and carpenter shop are fitted with a full set of working tools, and in one corner of the pattern shop is located a tin shop equipment. The building is 52 ft. 4 ins. span and 192 ft. long. The warehouse is located adjacent to the shop, and is 80 ft. span by 217 ft. long.

THREE-HINGED CONCRETE ARCH HIGHWAY BRIDGE OVER THE MAIN AT MILTENBERG, GERMANY.*

(With full-page plate.)

Since the middle of the last century various projects have been put forward for connecting the right bank of the River Main with the city of Miltenberg by means of a bridge. Recently the growth of a considerable population, and finally the assured building of a station there by the Miltenberg-Stadtprozelten Ry., which is a branch of the Wurzburg-Worms Ry., made the need of a bridge imperative. The work of designing the bridge, together with much valuable information and plans relating thereto, was entrusted to Mr. Eduard Fleischmann, and the following design is due to him and his collaborator, J. B. Bosch. The contract for a three-hinged rubble-faced concrete arch bridge was let to Grün & Bilfinger, of Mannheim, who carried through the work during the years 1898 and 1899. The architectural features of the structure are due to Professor Hofman, of Darmstadt. The contract price for the whole work, exclusive of approaches, alterations in streets, etc., amounted to $101,250.

The bridge crosses the Main by six spans (Fig. 1), three stream openings and three flood openings, at some rapids at the beginning of a sharp bend in the river. At present the bridge terminates on the city side on the Main strasse, with inclined planes and a stairway, pending the erection of suitable approaches above high water mark. At the other terminus a short embankment connects the bridge with the new district

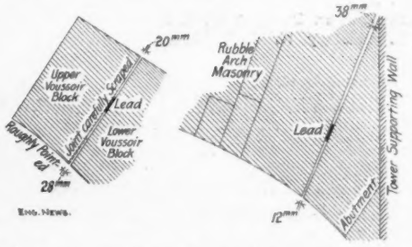

Fig. 9. Hinge at Pier; Centering in Place.

Fig. 10. Hinge at Abutment; Centering Removed.

highway. The right bank of the river was excavated in order to maintain a proper flood cross-section of the river without endangering the city. The former navigable channel lay near the middle stream span. A channel was dredged in the middle of this span 72 ft. wide and 0.6 ft. below the normal river bed, in a very hard stratum. The length of the several spans are so chosen as to give a symmetrical appearance. The middle two spans are each 112 ft. in length, with a rise of 17.7 ft. above the springing lines; the two adjoining spans are each 107.3 ft. in length, while the terminal spans have a length of 102.3 ft. The heights of the piers vary from 11.2 to 16.1 ft. The total length of the bridge is 733 ft. The roadway is 14.4 ft. in width, with footways on each side 4.9 ft. in width. The profile of the bridge is parabolical, the steepest grade being 1.39%. The clear height above the highest water level in the navigable channel is 22 ft.

The abutments and piers are founded upon a stratum of sandstone, lying at from 2 to 12 ft. below low water level. The vertical foundation pressure at the abutments is 69 lbs. per sq. in., and the horizontal thrust is from 88 to 92 lbs. per sq. in. Piers I., II. and IV. are built upon a bed of concrete, 3.28 ft. thick, composed of one part cement, three of sand and six of broken stone. Pier III. is built upon a similar bed, 4.4 ft. thick. Pier V. and the left abutment rest directly upon the bed rock. The foundation walls are of rough rubble work, laid with Portland cement mortar.

The piers have a slightly curved profile, and are 10.15 ft. in width at the springing line. The upstream faces are sharp, while the downstream faces are rounded. The former are faced with iron as a protection against ice floes. Each pier is crowned by battlements. The masonry above the ground or water lines is of rubble-faced concrete, in the proportion of one part cement, one part sand and six parts broken stone. The visible surfaces are faced with roughly-dressed stone of various sizes and laid in short courses. The corners of the abutments and upper parts of the piers are faced with blocks, which, in the piers, are clamped together. The capstones are dressed.

The arches, which are 23 ft. wide, are three-hinged, the pressure being borne by narrow strips of lead. The arches were laid out according to a regular curve, which was designed for a load represented by a street roller with six tons on the forward axle and nine tons on the rear axle, and a distributed load of pedestrians of 111 lbs. per sq. ft. The weight of the masonry itself was found by experiment, and the centering was laid out and constructed upon the shop floor. The sharp angle formed with piers by the curve so found was avoided by filling out these places with a tangential rounded curve. The thickness of the crown of arches I. and IV. is 2.3 ft., and of the remaining arches 2.46 ft. The corresponding thicknesses at the springing line are 2.64 and 2.79 ft.

The lead plates are 0.78 ins. thick and varying in width from 5 to 6 ins. They are placed between blocks, 1.6 and 1.8 ft. thick at the springing lines and 1.5 ft. thick at the crown.

The maximum pressure in the masonry is 360 lbs. per sq .in. According to experiments made by Bauschinger, this gives a factor of safety of ten. The pressure upon the lead plates is 1,725 lbs. per sq. in. This pressure must be taken up by the blocks of sandstone resting upon the lead, which they are able to do, since the pressure acts only upon a narrow strip of about one-sixth the height of the block. According to experiments by Durand-Caye and Professor Bach, the factor of safety here is eight.

The arches are drained by cast-iron pipes placed at the lowest points.

The arches are built of concrete of the composition, one part cement, ¼ part sand and 3 parts stone. The under surfaces of the arches are pointed and the face stones are roughly shaped. The hinge blocks are treated in the same way, except that the bearing surfaces are nicely dressed. The spandrel walls and the abutments are faced with stone laid in irregular courses.

The superstructure of the arches consists of the two exterior spandrel walls and three others which run parallel with them and serve to support the concrete roadway. They extend over the whole length of the bridge from one abutment to the other, broken only by openings at each pier, serving as an expansion joint and drainage opening. The side walls are also broken at these joints, the joints being concealed at the corners of the piers. The concrete roadway resting upon the longitudinal walls has a thickness of 5.5 ins. at the middle and 4.3 ins. at the sides. Its strength is augmented by embedded corrugated-iron bands 1.97 × .079 ins., placed 9.9 ins. center to center, and hung upon the beams resting upon the longitudinal walls. The road bed is provided with expansion joints at the piers, which are covered by iron plates. In order to protect the concrete road bed and the arch itself from percolating water, the surface of the former is covered by an asphalt coating, which joins with the concrete sidewalks. The surface water is carried away by cast-iron pipes placed at the crowns of the arches. The spandrel walls consist of concrete blocks. The railings are constructed of cast iron, in order to save space.

The city end of the bridge is ornamented by a tower gate, which contains the living rooms of the toll takers. The terminus of the bridge on the right bank is marked by two cast-iron color standards.

The bridge is constructed principally of the vary-colored sandstone found in the surrounding country. Red sandstone is used for the cappings to the piers, and in gateways, doors, etc. The entire bridge and approaches was built and completed in the time between March, 1898, and December, 1899.

The bridge was tested on Dec. 6, 1899, by means of a steam road roller, weighing six tons on the forward axle and nine tons on the rear axle. Each

*Abstracted from an article by Eduard Fleischmann in "Zeitschrift für Bauwesen."

posited in the yard for winter use. In the winter season, the Brown machines with scoop buckets gather material from stock pile and deposit it into stock bins or into deep bottom cars, from which the material is transferred to the supply bins, from whence it is taken to the furnaces by the scale cars. The bins for storage are all of the same cross-section and are 56 in number. There are four large coke bins over the center of each skip pit, in which the coke is fed directly into the skip car, which takes it to the furnace. There are 28 bins for use of ore or limestone, or seven for each furnace.

The Brown machines are independent motor driven, the span of the bridges being 225 ft. and the cantilever 105 ft. The back leg of the machine is mounted on rails 18 ft. c. to c. The motors are located on the truck of the back leg of the machine, and are enclosed in a suitable engine house. The operators' house is located directly above and on the side of the leg of the machine.

BLAST FURNACE PLANT.

There are four furnaces built and erected by the Riter-Conley Mfg. Co., of Pittsburg, Pa. The furnace stacks are 20 ft. in diameter at the bosh and 85 ft. high. The diameter of the hearth is 11 ft. 9 ins., and the diameter at the stock line is 14 ft. 6 ins. There are twelve 6-in. tuyeres. Each furnace is provided with Julian Kennedy's patent top filling apparatus. The furnace shell is 28 ft. diameter at the mantle and 23 ft. at the top of the furnace. The tuyere stocks, 12 in number, have ball joints and adjustable blow pipes. The skip hoist leading from under the stock bins to the top of the furnace is of structural stel and carries two skip cars which rest at the bottom in a steel-cased pit.

The stoves are of the Cowper type, with casing 21 ft. in diameter by 85 ft. high. The stove chimneys are 9 ft. in diameter inside of lining, and 200 ft. high, and are provided with heavy cast iron bases bolted to the foundation.

The boiler house is, as shown on the plans, 53 ft. wide and 576 ft. long. It is a steel building with brick walls and heavy concrete foundations, and contains two 4,000-HP. boilers, with two steel stacks, one for each boiler. These stacks are 11 ft. in diameter inside of lining, and 200 ft. high. The boilers are connected to these stacks by overhead breeching. The boilers are of the Babcock & Wilcox type, designed for a working pressure of 150 lbs. per sq. in.

The engine house is 44 ft. 2 ins. wide and 200 ft. long and contains five pairs of blowing engines built by the E. P. Allis Co., and commanded by one 30-ton electric overhead traveling crane. These engines each have a high pressure cylinder 50 ins. in diameter, a low pressure cylinder 96 ins. in diameter, with a blowing tube 96 ins. diameter, all with a stroke of 60 ins.

The pump house, which is a lean-to on the engine house, is 30 ft. wide and 200 ft. long and contains three horizontal Wilson-Snyder compound, direct-connected, circulating pumps, having steam cylinder 18 × 32 ins. and bronze plungers 24 ins. in diameter by 36 ins. stroke. The pumps are each rated at 6,000,000 gallons per 24 hours. All pumps are connected to an exhaust line extending to the end of the engine house with connections leading to the condenser system. Provision is made for the connection of a fourth pump if desired.

These pumps obtain their water from the harbor, and will be connected to a 20 × 35 ft. standpipe, which will supply water for circulating and cooling purposes.

The pump house contains a pair of surface condensers built by the Northey Mfg. Company, of Toronto. Through these the return water from the furnaces will be used for condensing purposes. The fresh water supply line leads to the wall of the engine house and has connection to the boiler feed pumps, which are three in number and are duplex, outside backed, plunger type, 14 × 9 × 18 ins. stroke. These pumps were built by Wilson-Snyder Mfg. Co., Pittsburg.

A valve is placed on the fresh water line for connection to the main salt water well and to the salt water discharge line from the pumps, enabling the use of fresh water in case of emergency for cooling purposes. To the Northey condensers in the pump house there is a connection leading through the wall to a line to the electric power station.

ELECTRIC POWER STATION.

This part of the equipment consists of three 300-K-W. electric generators, built by the Canadian General Electric Co., and each driven by a cross-compound condensing engine with cylinders 20 and 40 ins. diameter, 42-in. stroke, built by Laurie & Co., of Montreal.

The building, which is 51 ft. 3 ins. span by 130 ft. long, is of steel, with brick wall filling; the structural work was furnished by the Dominion Bridge Co., of Montreal. The electric machinery is commanded by a 15-ton crane, also designed and built by the Dominion Bridge Co.

The switchboards, booster and electric appliances are all of the latest type, and the entire equipment of the electric power station was furnished by Canadian manufacturers.

OPEN-HEARTH FURNACE PLANT AND ACCESSORIES.

The metal from the furnaces will be taken in 25-ton ladle cars to a motor-driven pig casting machine, which was built by the Heyl-Patterson Co., of Pittsburg, Pa., and which has a capacity of 1,600 tons per 24 hours, or hot metal may be taken direct to the open-hearth furnaces, which are, as above stated, ten in number and of 50 tons capacity. They are of the tilting type. These are arranged in a row, and metal may be put into the furnace from either side, or cold pig or stock may be placed in the furnaces by two Wellman-Seaver charging machines.

The product of the furnaces, which is estimated at 1,400 tons per day, will be tapped into 50-ton ladles, from which it is poured into the molds on cars, and transferred to the stripper building to be deposited in the pit furnaces. The open-hearth building has a span of 65 ft., with a lean-to 37 ft. wide, 232 ft. long.

The gas for the open-hearth furnaces will be partly from producers of the latest improved type and partly from the coke ovens. A 1,000,000 cu. ft. triple lift gasholder is located as shown on the plans adjacent to the furnaces, and is so constructed as to give a working pressure of 5 ins.

The Blooming mill has a 35-in. train was built by the Mackintosh-Hemphill Co., of Pittsburg, Pa., and is direct driven by a pair of [illegible] × 60-in. reversing engines. The mill is commanded by two 20-ton electric overhead traveling cranes, built by Brown Hoisting & Conveying Machine Co., to be used also for charging or drawing ingots from the pit furnaces.

The mill and pit furnace building is 31 ft. 10½ ins. wide, 480 ft. long, and contains 16 pit furnaces of the latest type, also the necessary approach tables, main tables, and hydraulic and steam shears.

The blooming mill boiler house is 46 ft. span, 286 ft. long, and contains 3,000-HP. of Babcock & Wilcox boilers, all located as shown on the plan. One section of the boiler house contains three hydraulic pressure pumps, furnished by the Northey Mfg. Co., of Toronto, Ont. The hydraulic system will be of the return type and designed for a working pressure of 500 lbs. to the square inch with suitable accummulators and operating valves.

The boiler feed pumps are of the compound duplex type, also made by the Northey Mfg. Co.

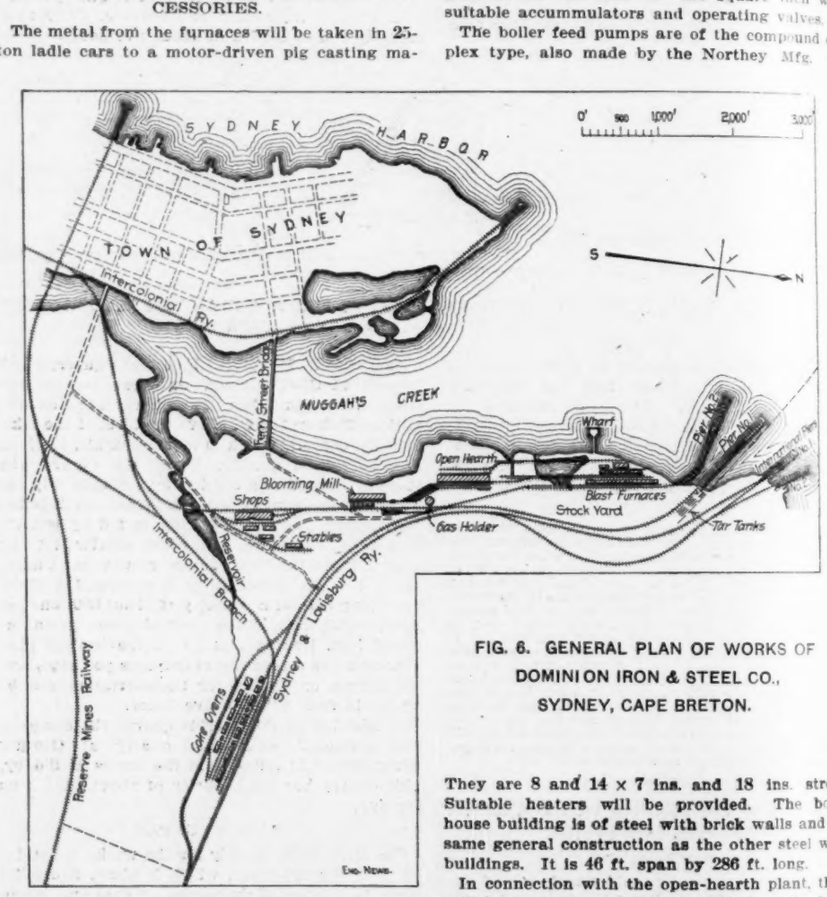

FIG. 6. GENERAL PLAN OF WORKS OF DOMINION IRON & STEEL CO., SYDNEY, CAPE BRETON.

They are 8 and 14 × 7 ins. and 18 ins. stroke. Suitable heaters will be provided. The boiler house building is of steel with brick walls and the same general construction as the other steel work buildings. It is 46 ft. span by 286 ft. long.

In connection with the open-hearth plant, there will be erected a calcining, grinding and mixing plant of a capacity sufficient to furnish all refractory material linings, etc. This plant will be equipped with the usual mixers, crushers, elevators, bins, and calcining cupolas.

The building will be made of steel with brick wall filling.

The stripper building will be of structural steel covered with corrugated iron and of the usual tower type 35 × 35 ft. in size, and containing the double cylinder Aiken stripper and double set of car pushers, duplicates of the pushers which will be used in the open-hearth mill.

The ladle repair shop will be located at the end of the furnace plant, and will be a 35 × 80 ft. steel building, bricked in, and provided with crane runways and hand or electric crane of 15 tons capacity. There will be sufficient room for the handling and repairing of six ladles.

It is planned to discharge a large quantity of tar on one side of the No. 2 pier. The tar will be

of the land spans was provided with a device for recording the deflection at the middle of the span while the roller was being driven over it. When the roller was driven slowly across, the crown of the arch sank 0.197 to 0.316 ins., and when it crossed quickly this was increased to 0.434 ins. There was no permanent deflection produced.

WIDE FIREBOX LOCOMOTIVE FOR BURNING ANTHRACITE CULM; DELAWARE, LACKAWANNA & WESTERN R. R.

We illustrate in the accompanying cuts one of nine passenger locomotives now being built for the Delaware, Lackawanna & Western R. R., by the Schenectady Locomotive Works. The locomotive is chiefly notable for the great width of the firebox employed, and for the combination air and steam jet apparatus used for blowing away the ashes from the sides of the ash pan. The fuel used being a very poor grade of anthracite culm, special provision is required for its successful combustion, and the arrangement used here is the outgrowth of the experience and experiments of Mr. T. S. Lloyd, Superintendent of Motive Power, Delaware, Lackawanna & Western R. R., in handling this fuel. Mr. Lloyd states that the arrangement has been found to work very satisfactorily.

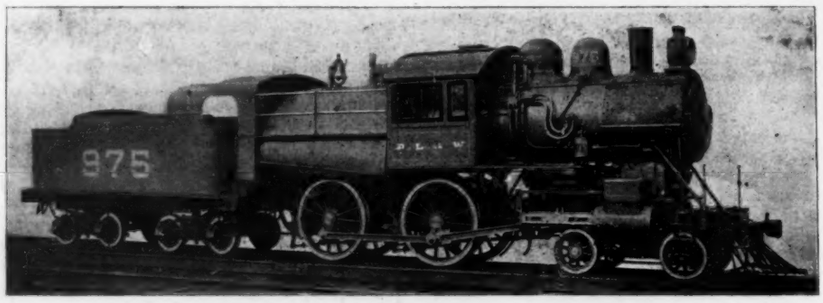

FIG. 1. EIGHT-WHEEL WIDE FIRE-BOX PASSENGER LOCOMOTIVE; DELAWARE, LACKAWANNA & WESTERN R. R.
T. S. Lloyd, Superintendent of Motive Power, D., L. & W. R. R.
Schenectady Locomotive Works, Schenectady, N. Y., Builders.

Referring to the illustrations, Fig. 1 is a general view of one of the new engines, the main dimensions of which are given below in our standard tabular form. By examining this view it will be seen that the steam jet blowers are located on the grate line, just above the rear drivers. The transverse and longitudinal dimensions of the grate are clearly indicated by Fig. 2 and Fig. 3. Fig. 4 shows the details of the ash ejector, and Fig. 5 details of the ash pan construction.

General Dimensions of Eight-Wheel Wide-Firebox Passenger Locomotive; D. L. & W. R. R.

GENERAL DESCRIPTION:	
Class of traffic	Passenger.
Gage of track	4 ft. 8½ ins.; fuel, Anthracite.
No. of driving wheels	4; No. of truck wheels, 4
RUNNING GEAR:	
Driving wheels, No.	4; diameter, 5 ft. 9 ins.
Truck wheels, No.	4; " 2 " 9 "
Tender wheels, No.	8; " 2 " 9 "
Driving wheel centers	Cast steel.
Truck and tender wheels	Steel tired.
Driving-wheel tires secured†	By shrinkage.
Engine truck	Rigid center.
Journals, driving axles	9 x 13 ins.
WHEELBASE: Driving	8 ft. 6 "
Total engine	23 ft. 3 "
Tender, 16 ft. 9½ ins.; engine & tender	50 ft. 11¾ "
WEIGHT IN WORKING ORDER:	
On driving wheels	93,000 lbs.
Engine, total	139,000 "
Tender, empty	48,150 "
CYLINDERS: No.	Two.
Diameter and stroke	20 x 26 ins.
VALVE GEAR:	
Ports, steam, 18 x 1¾ ins.; ports, exhaust	18 x 3 ins.
Bridges, width	1¾ ins.
Slide-valve, style	Allen-Richardson Balanced.
Maximum travel	5½ ins.
Inside lap, ⅛-in.; outside lap	⅞-in.
Lead (full forward gear)	1-16-in.
BOILER: Type	Straight, with wide firebox.
Diameter barrel outside first ring	5 ft. 1 in.
Thickness, barrel plates, 19-32, ½, 5-16,	11-16-in.
Horizontal seams	Sextuple riveted.
Circumferential seams	Double riveted.
Butt joints	With strip inside and outside.
Injectors, No. 1; Kind	Hancock Composite.
Working steam pressure	185 lbs.
FIREBOX:	
Length inside, 10 ft. 6 ins.; width inside	8 ft. 4 ins.
Depth: Front, 4 " 8 "; back	3 " 10 "
Thickness, side plates, ⅝-in.; back plate	⅝-in.
Crown plate, ⅝-in.; tube plate	9-16-in.
Kind of crown stays	Radial, 1½-in. diameter.
Kind of grate bars	Rocking, in six sections.
Stay bolts, diameter	⅞-in.
Water spaces, width: Front, 4; back, 3½; sides, 3½	ins.
TUBES:	Charcoal iron.
Number, 280; diameter	2 ins.
Length over tube plates	13 ft. 4 "
HEATING SURFACE AND GRATE AREA:	
Heating surface, tubes	1,947.87 sq. ft.
" " firebox	195.40 "
" " total	2,143.27 "
Grate area	87.67 "
MISCELLANEOUS:	
Exhaust nozzle, Single; diameter	4¾, 5 and 5¼ ins.
Smokestack, diameter at top	17½ "
Diameter at base	18 "
Height of top above rail	15 ft.
Capacity of tender tank	5,000 gallons.
Capacity of coal space	20,000 lbs.
Brake fittings	Westinghouse-American.

We are indebted for the information from which this description has been prepared to Mr. T. S. Lloyd, Superintendent of Motive Power and Machinery, Delaware, Lackawanna & Western R. R., and to the Schenectady Locomotive Works, Schenectady, N. Y.

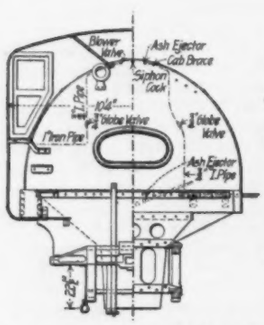

Fig. 2. Transverse Sections, Showing Width of Fire-Box, Passenger Locomotive; D., L. & W. R. R.

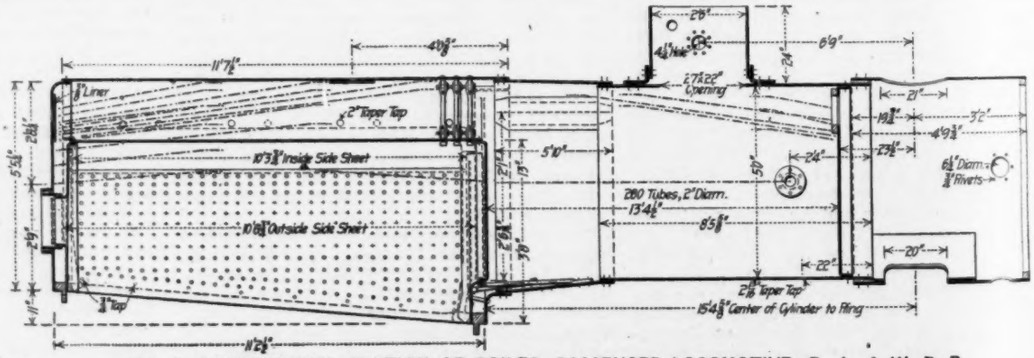

FIG. 3. LONGITUDINAL SECTION OF BOILER, PASSENGER LOCOMOTIVE; D., L. & W. R. R.

CHANCES FOR YOUNG ENGINEERS IN MEXICO.*

By J. M. Alarco.†

From my personal experience and constant intercourse with engineers in this country, my opinion is that the chances here are good, but although it may seem presumptuous, let me name some of the requisites to success in this country.

In the first place, that which is necessary for success in all countries, and under all circumstances: Don't be afraid of work. Not only that, show your employer you are willing and eager to do work. Next learn to speak and understand the Spanish language, which is worth 100% of your salary at the start and 1,000% later on. It has been my experience, I am sorry to say, that about one in every fifty of the Americans in this country speak Spanish only well enough to make themselves understood. Few take the trouble to learn Spanish thoroughly, consequently they fill only the lower positions in an office; and those that know it well, although perhaps not as efficient in their work, step above them and advance rapidly. Choose your employer, if possible; above all, select a gentleman and one who is willing to teach you. Another mistake of the Americans is that as soon as they are a month in Mexico alcohol and other things not to be mentioned get the best of them. They burn the candle at both ends and do not last long.

Outside of this general advice, it is best when coming here to be in the employ of a foreign firm, or come to fill a position secured beforehand—unless you have some capital to start for yourself. Mexicans, as a general rule, are not enterprising; and those that are and have money will award the contract for any enterprise they may undertake to a foreign firm and will employ foreign skill.

Opportunities there are galore. Every town of importance has an electric light system or is thinking of putting one in. All of them need a sewer system and public water supply. The matter is just waiting for some enterprising American firm to hustle it through. Although, as a general rule, the treasury of most cities is empty, they have the advantage of not being bonded, leaving, therefore, an untouched source of revenue and a way of raising money for future enterprises.

There are ranches of from 1 to 50 square miles in area, and whole sections of the country practically worthless for the lack of water. In many instances a dam can be built on the property at a very small cost, since material is handy and labor is cheap. A common laborer on the ranches gets 12 cts. per day in Mexican money and enough corn to make a meal. As for mining, there is a constant demand for a man willing to begin at the bottom, with the probabilities of taking a claim for one's self. The mining laws of Mexico are excellent and claim jumpers do not exist. They died long ago of an indigestion of lead.

Labor, as I have already pointed out, is both cheap and efficient. The Guggenheim Smelting Co. imported 200 Chinamen, but it didn't pay, as one Mexican, when he is willing to work, will do as much as two Chinamen for the same money. The regular price of unskilled labor in and around cities is from 35 to 50 cts. in silver per day, and that of the best skilled labor from $2 to $3 silver per day.

If the engineer, after graduating, stays in the States a couple of years, and gains the practical knowledge necessary to supplement the theory he has learned in college, then he can command a situation here in any branch of the profession. But do not let him come with the idea that he will find an up-to-date machine shop in the whole country, or that any of the standard-size materials can be bought in the open markets, as in the States. When erecting a plant of any kind, he must learn to use the material at hand, and operations that are done in the States with lathe or shaper must frequently be done here with hammer, chisel, hack-saw and file. If the specifications call for brick and cement, he must most of the time content himself with adobes, mud and lime.

*From "The Technograph" of the University of Illinois.
†Manager La Luz Electrica de Aguas, Calientes, Mexico.

Economy in the use of fuel is of the utmost importance here, for coal costs from $8 to $10 gold per ton; and fuel saving devices such as condensers, heaters and economizers, if not already attached to the engine, must be bought or contrived by the engineer or manager.

Any good engineer will get from $90 to $150 gold per month. As his living expenses are more than 50% lower than in the States, it follows that more money can be saved. The field is not crowded by any means, and all it needs is to get down here and hustle, and success will follow.

STUDIES OF PUBLIC WATER SUPPLIES BY THE OHIO STATE BOARD OF HEALTH.

A study of public water supplies from the Ohio River, and from Lake Erie, has been undertaken by the State Board of Health of Ohio. When completed, this will finish the special investigations of Ohio water supplies, begun by the board in 1897, the results of which, thus far, have been published in three special reports. In the Ohio Sanitary Bulletin for May-June, 1901, the Ohio River and Lake Erie problems are discussed as follows:

The Ohio River offers a specially difficult problem, as its pollution is beyond the control of the State of Ohio. It would be of little avail to require the sewage of Ohio cities discharged into this river to be purified as long as raw sewage from cities in other states enters it.

The following Ohio cities take water from the Ohio River: East Liverpool, Wellsville, Toronto, Steubenville, Mingo Junction, Martin's Ferry, Bridgeport, Bellaire, Marietta, Pomeroy, Middleport, Gallipolis, Ironton, Portsmouth, New Richmond and Cincinnati. Gallipolis obtains water from infiltration wells located upon an island in the Ohio River. Omitting this city, we have a combined population of 443,427 (census 1900) people depending upon the Ohio River for their water supply.

The up-river towns are most unfortunately located as regards sewage pollution of their water supplies. East Liverpool is 45 miles below the cities of Pittsburg and Allegheny, having a combined population of 451,512.

Wellsville is only about four miles below East Liverpool; Toronto ten miles below Wellsville; Steubenville the same distance below Toronto. Bellaire is less than ten miles below Martin's Ferry and Bridgeport (practically one city), and the same distance below Wheeling, W. Va., a city of 38,878 inhabitants.

It is more than doubtful whether the Ohio River, unless purified, affords anywhere in Ohio water suitable or safe for domestic purposes. Not only does it contain at all times a large amount of sewage, but the rains wash into it so much mud as to render it at times unfit even for bathing purposes. The people, fortunately, are insisting more and more upon being supplied with pure, clear water; and municipal authorities must soon be prepared to meet this demand.

Fortunately it is possible by a system of filtration to purify river water even more grossly polluted than the Ohio. Cincinnati is building filter works, and we trust to see in the near future other Ohio River towns following this lead. • • •

Cities upon the shores of Lake Erie do not, as many suppose, find at their doors an abundant supply of pure water. Certainly there is enough of it, but it is often far from pure. The lake cities are learning to their cost that it may not be safe to depend upon the lake to get rid of their sewage and furnish them at the same time a pure drinking water. At least there must be a wide separation between where the sewage enters and the water is taken out. How far this separation should be to avoid danger can scarcely be predicted in any case. Cleveland is building an intercepting sewer to deliver all its sewage ten miles from the intake of their water supply. Will this be far enough?

We may look forward to the time when all our surface water supplies will be purified, and the sooner this time comes the better it will be for the public health.

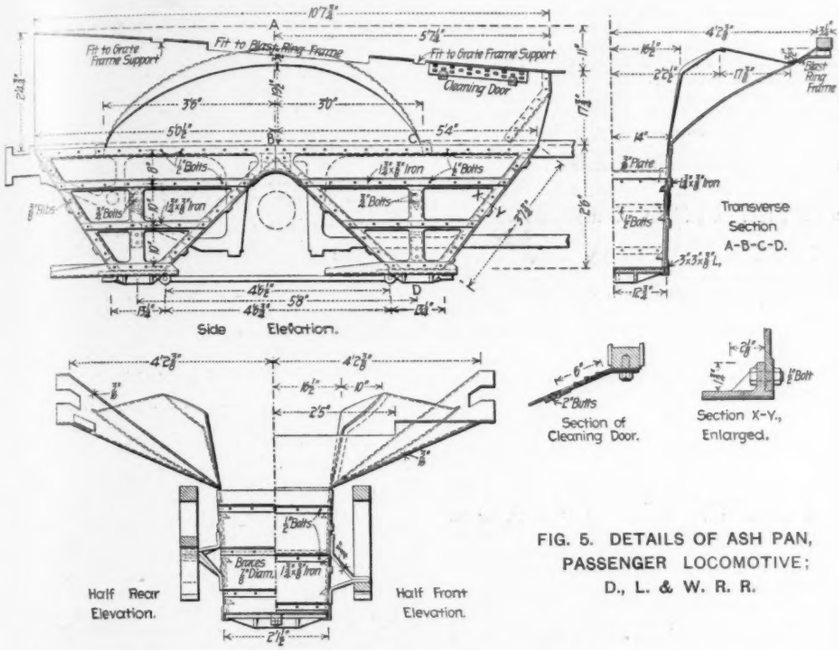

FIG. 5. DETAILS OF ASH PAN, PASSENGER LOCOMOTIVE; D., L. & W. R. R.

Mr. C. O. Probst, M. D., of Columbus, O., is secretary of the Ohio State Board of Health, and editor of the "Bulletin." The latter contains frequent notices of sanitary engineering developments in Ohio.

BOOK REVIEWS.

WATER FILTRATION WORKS.—By James H. Fuertes, M. Am. Soc. C. E. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 5 x 8 ins.; 19 plates and 45 figures in the text. $2.50.

This book includes the accessories of filtration works, from intakes and settling basins to clear-water reservoirs, instead of being confined, as the title implies, to filters alone. It is prefaced by an introductory chapter in which the author discusses a variety of questions related to his subject. These include the effects of aeration, freezing, storage, mud deposits in reservoirs and in distribution systems, and the protection of water supplies against pollution. After proceeding with "Intakes, Sedimentation, and Settling Basins," the author takes up first slow and then rapid filtration, and combinations of the two. A little is said relating to the Anderson process of iron treatment, the Pasteur baked-porcelain filter tubes, the Fischer, or Worms, hollow stone-plate filters. The Maignen asbestos-covered sand filters are dismissed with five lines, as not in use in the United States. The concluding chapter is on "Filtered-Water Reservoirs." The author has carried out the very good plan of treating the four main divisions of his subject; that is, settling basins, slow filters, rapid filters, and clear-water reservoirs, under the successive heads of design, construction and operation. Formulas and diagrams are introduced to aid in solving various problems which occur in design or operation. Details of design add greatly to the value of the book. These include illustrations of devices for automatically regulating the rate of filtration and for other and similar purposes.

The book has been written in the light of both American and foreign experience, including the investigations at Lawrence, Providence, Louisville, Cincinnati, Pittsburg and Washington, and the preliminary studies at Philadelphia. It has all the advantages of a a fresh treatment of an old topic, in which the new may be discussed in the light of the old and the old in the light of the new. The typography is excellent, and so are most of the illustrations. The latter features, combined with a medium size, make it a very convenient and attractive book, while its subject-matter renders it a most useful one.

THE CITY FOR THE PEOPLE.—Or the Municipalization of the City Government and of Local Franchises. By Frank Parsons, Lecturer in Boston University Law School, etc., etc. Philadelphia: C F Taylor. Cloth; 6 x 9 ins.; pp. 597; tables. $1.

A large part of this volume is taken up with a detailed discussion of public ownership. Then follow sections on direct legislation, home rule, the merit system, proportional representation, preferential voting, the automatic ballot, and plans for overcoming municipal corruption. The book is brimful of arguments in behalf of the principle indicated by the title. The arguments are supported by numerous citations from other writers and by quite an array of figures from various sources. The author makes little attempt to present the other side of the case, which may be due to the earnestness of his convictions that the other side has no case, or is able to take care of it if it has. In the section on municipal ownership some of the conclusions are based on inadequate statistics and others seem to be unwarranted from the statistics in hand. As an instance of the latter we may cite a table on p. 147, giving the average daily water consumption in gallons per family for 20 public and 20 private works. The figures are given to illustrate the principle that "increase of business is one of the marked advantages of public ownership." They would serve equally well, without going below the surface in either case, to show the great wastefulness of public as compared with private ownership. Thus, we have in the public ownership list cities notorious for water waste, like Buffalo, Philadelphia, Washington, Pittsburg and Camden. In calling attention to such features of the book we do not wish to discredit either the book, the author or the cause which he is so zealously championing, but merely to make clear that all should be taken with due allowance for the fact that we have here the work of an enthusiastic propagandist, whose conclusions must be weighed with that fact constantly in mind. With this limitation we commend the book to all who are studying some of the greatest problems of the day, namely, those relating to municipal administration.

A BIBLIOGRAPHY OF MUNICIPAL PROBLEMS AND CITY CONDITIONS.—By Robt. C Brooks. Second Edition, Revised and Enlarged. Complete to Jan. 1, 1901. New York: Reform Club, Committee on City Affairs. Cloth; 6 x 9 ins.; pp. 346. $1.50.

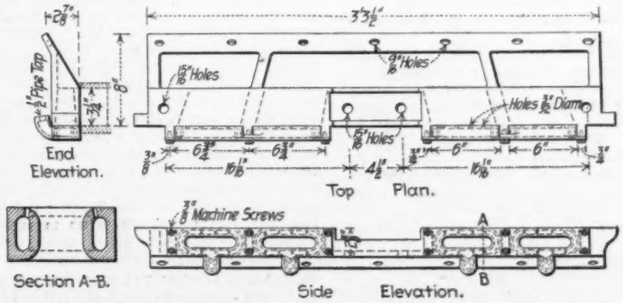

FIG. 4. DETAILS OF ASH EJECTOR, PASSENGER LOCOMOTIVE, D., L. & W. R. R.

A more welcome addition to the library of all having occasion to refer to the literature of municipal affairs than is afforded by this volume it would be hard to find. Books, technical and other journals and magazines, society proceedings and both state and national publications, are all included in this bibliography. The aim has been to include every valuable source of information on all phases of municipal activities and interests, from pav-

ing, sewerage, water supply, lighting and transit facilities to forms of government and such questions of morals and manners as the regulation of saloons and the curfew hour for children.

The bibliography contains some 12,000 entries in the subject index and nearly 4,500 names in the index to authors. Foreign countries and languages are included, but the bulk of the references are to American and British books and articles, with America far in the lead. All of the entries relating to specific towns and cities are entered thereunder, but cross-references are made under the general subjects concerned. New York city has 26 pages, with numerous entries classified under such heads as garbage disposal, lighting, parks, playgrounds, sewerage and water supply. Lighting and water supply have about eight pages apiece, with cross-references to New York and other cities in an opening paragraph. Obviously, some such system was necessary to prevent undue bulk and expense.

It may be added that this very handy and valuable piece of work is supplemented four times a year in "Municipal Affairs," which, like the consolidated bibliography, is published by the New York Reform Club's Committee on City Affairs. We should have no hesitation in commending such a notably good work if it were being done for profit, but since it is a labor of love we take all the more pleasure in bespeaking for it a hearty support. The original edition of the bibliography, and the quarterly supplements from 1897 to date, have been one of the most useful reference books in our office. We heartily commend them to others.

THE INTERNATIONAL YEAR-BOOK.—A compendium of the world's progress during the year 1900. Editor, Frank Moore Colby, M. A.; Consulting Editor, Harry Thurston Peck, Ph. D. L. H. D., Professor in Columbia University. New York: Dodd, Mead & Co., Publishers. Cloth; 6½ × 9¾ ins.; pp. 1,061; illustrated. $3.

The third issue of this year-book, commenced in 1898, follows the general plan of the previous volumes; though the unusual importance of the political record for 1900 has extended its bulk, and to this volume has been fittingly added a concise resume of the progress of the 19th Century. The purpose of this publication can be best expressed by comparing it to an annual newspaper, which deals with the personages, governments and events of the year. Politically, the year 1900 was especially important, with a Presidential campaign in the United States, and the international complications in China and South Africa; and these subjects are so dealt with as to fairly present the views of the opposing parties. Under the heads of nations and states we find a summary of existing conditions, statistics and governments, and a statement of all interesting events; all scientific advance is noted in its many branches, and the death of all prominent people in the year is marked by a sketch of their life and works. The subject of municipal government is given an unusual prominence in this volume; and in this connection it may be said that all scientific and economic articles are contributed by specialists in each case. This is also true of the broad statement of progress made during the past century in science, art, literature, commerce, etc. A general index to the three issues of 1898, 1899 and 1900 is included.

ROAD MAKING AND MAINTENANCE: A Practical Treatise for Engineers, Surveyors and Others. With an Historical Sketch of Ancient and Modern Practice. By Thomas Aitken, Assoc. M. Inst. C. E., Surveyor to the County Council of Fife, Cupar Division. London: Chas. Griffin & Co. Philadelphia: J. B. Lippincott & Co. Cloth; 7 × 9 ins.; pp. 440; 139 illustrations. $6, net.

The author of this volume gives evidence of having had much experience in all that pertains to road making and maintenance, and of having kept posted as to the experience of others. The results are here set down in a clear and orderly fashion, supplemented by well-chosen illustrations. Among the latter are a number of good half-tones, which seem to lessen the distance and add to the reality of the field of operations so well described in the text.

Roads are here used broadly enough to allow the author to devote some half-dozen chapters to city pavements, and one to subways, but about three-fourths of the volume is taken up with the laying out, improvement and maintenance of country roads and those urban streets for which broken stone roadways are sufficient.

The book is particularly useful because it recognizes the value and describes the methods of substituting machine for hand labor in both construction and maintenance. Thus there are first-class chapters on "Quarying," "Stone Breaking and Haulage," "Road Rolling and Scarifying," and a thorough discussion of the best methods of repairing and of cleaning macadam roads. Detailed figures of cost are presented in a most gratifying manner, and since many of these are inserted to show the relative advantages of different methods they are of universal interest. The author favors the intermittent system of repairing, or at least of resurfacing, macadamized roads, rather than the patchwork system. His reason is that a continuous resurfacing is more economical, particularly in the matter of road rolling. The patchwork system requires a large amount of lost time for the roller, or, if carried to an extreme, makes its use impossible. The book should prove a valuable addition to the library of engineers in all countries, and particularly in America, in most sections of which the era of scientific road improvements is just beginning.

GAS ENGINE CONSTRUCTION: A Practical Treatise Describing the Principles of the Action of Gas Engines of Various Types and the Designs and Construction of a ½-HP. Gas Engine.—By Henry V. A. Parsell, M. Am. Inst. E. E., and Arthur J. Weed. New York: Norman W. Henley & Co. Cloth; 6 × 9 ins.; pp. 296; illustrated. $3.

The scope and purpose of this book are well set forth in the preface as follows:

The authors have endeavored to give the amateur in this book: first, a broad and thorough knowledge of the principles of various forms of gas engines; second, a full and concise description of the making of a regular gas engine by practical shop methods, avoiding the makeshifts and bungling so prevalent in the toy machine books; third, a set of modified rules for designing similar engines, followed by a guide list of books and periodicals useful to the student.

The design of a small engine referred to above occupies by far the greater part of the volume, and is given with great detail and in a very clear manner. The chapters on the principles and general design of gas engines are evidently intended and well serve to enable the amateur to better understand the design given. The illustrations are excellent for the purpose of instruction, since they show not only drawings and photographs of parts of the engine, but also the manner in which the work should be handled in the machine shop. The engine described is a four-stroke cycle horizontal engine, with a 2½ × 4-in. cylinder, giving about ½-HP. at 450 revs. per min. To build it requires a 10-in. bench lathe.

COMMISSION DES METHODS D'ESSAI DES MATERIAUX DE CONSTRUCTION.—Deuxieme session. Ministre des Travaux Publics. Paris, 1900. Imprimerie Nationale, Vve. Dunod. Editeur, Qual des Grande-Augustins 49. Vol I., Documents Generaux. Paper; 9 × 13¾ ins.; pp. 86. Vol. II., Rapports Particuliers. Paper; 9 × 13½ ins.; pp., 351; folding plates. Vol. III., Rapports Particuliers. Paper; 9 × 13½ ins.; pp. 263; illustrated. Price for the three volumes, $12.

This commission for methods of testing materials of construction was organized Nov. 9, 1891, under a decree of the French government, as the result of a resolution passed at a meeting of two of the international congresses convening at the Paris Exposition of 1889. The present publications relate to the session of this commission at Paris, commencing on June 8, 1900. The first volume covers the general reports on physical, chemical and mechanical methods of testing, and a summary of the conclusions adopted. The other two volumes include about 35 papers and notes upon a wide range of subjects connected with the object for which this commission was founded. The character of these papers can be judged by noting some of their titles, as follows: Interior tension and defects in the homogeneity of steels, by M. Barba; Use of the metallographic microscope, M. Osmond; Cooling curves in some steels, Leon Levey; Tests of steel, iron and cast iron by analytical chemistry, Adolphe Carnot; Relation between the phenomena of elasticity and the molecular constitution of the mass, M. Ricour; Influence upon the results of the rapidity of tests of the rupture of metals by tension, M. Ledoux; Method of testing natural stone for construction, M. Gautier; Testing artificial stone, M. Viallet; Permeability of materials of construction, MM. Thelat and Cordeau; Methods of testing materials employed in road construction, M. Monmerque. Other papers give methods of testing cordage, leather, paper, textile fabrics, gutta percha, etc. As a rule, these papers briefly describe and illustrate the test apparatus, describe the conditions of test and tabulate the results obtained, and at the end sum up these results or give definite conclusions.

HORSELESS VEHICLES, AUTOMOBILES, AND MOTOR CYCLES.—By Gardner D. Hiscox. New York: Norman W. Henley & Co. Cloth; 6 × 9 ins.; pp. 469; illustrated. $3.

This book contains more or less technical descriptions of nearly all the motor vehicles manufactured in the United States and for anyone wishing to familiarize himself with the "present state of the art" or to purchase a machine it would be very valuable. Much of the matter, including the illustrations, has evidently been taken bodily from trade catalogues. However, this does not diminish the value of the book as a volume of reference. In two introductory chapters the author has given a general and historical discussion of the subject and in another chapter he has given directions for building an electric cab. Two chapters giving lists of the patents on and manufacturers of automobiles in the United States are valuable features. The titles of some of the other chapters are as follows: Steam Propelled Vehicles and Automobile Carriages; Horseless Vehicles with Explosive Motors (the author probably refers to explosion motors); Operating Devices and Speed Gears; Electric Motive Power for Vehicles; Compressed Air Power for Vehicles.

SIGNALING ACROSS SPACE WITHOUT WIRES: Being a Description of the Work of Hertz and His Successors. —By Prof. Oliver J. Lodge, F. R. S. Revised edition. New York: D. Van Nostrand Co. Cloth; 5½ × 9 ins.; pp. 133; illustrated. $2.

This book is largely made up of notes of a lecture delivered by Dr. Lodge before the Royal Institution of Great Britain on June 1, 1894. An account is also given of later applications of wave experiments to wireless telegraphy. The work is not at all severely technical and is written in a very entertaining manner and should, therefore, be of considerable interest to the general reader or to anyone desiring to become acquainted with the methods and materials of wireless telegraphy. The titles of the chapters of the book are as follows: Royal Institution Lecture on the Work of Hertz and Some of His Successors; Application of Herts Waves and Coherer Signaling to Telegraphy; Details of Other Telegraphic Developments; A History of the Coherer Principle; Communications with Respect to Coherer Phenomena on a Large Scale; Photo-Electric Researches of Drs. Elster and Geitel; Photo-Electric Researches of Professor Righi.

CENTRAL STATION EXPERIENCES.—A series of narratives on the trials and tribulations of a young engineer while learning to run an electric station. From "Power." New York: The Power Publishing Co., World Building. Boards; 6 × 9 ins.; pp. 100; illustrated. Boards, 75 cts.; cloth, $1.00.

The writer assumes that a small town has been equipped with a 50-light Brush arc dynamo and two 500-light incandescent machines; and that the engineer in charge is a bright young fellow, with some little theoretical but no practical experience in operating electrical machinery. In the form of short stories the author goes on to narrate the trials of this young man in connection with the mishaps inherent in electrical apparatus in the charge of inexperienced men. Fortunately, Mr. Jones, who installed the plant, is within call; and in each case Mr. Jones explains by word and diagram just how each accident occurred and how it can be avoided in the future. Later in the day, an electric railway is added to the plant, and a similar series of troubles arising from this cause is dealt with by the engineer and his mentor. Much practical and excellent advice is thus given, in a popular form, relating to the proper running of an electrical plant.

COMMUNICATIONS PRESENTEES DEVANT LE CONGRES INTERNATIONAL DES METHODES D'ESSAI DES MATERIAUX DE CONSTRUCTION. Paris du 9 au 16 Juillet, 1900. Tome I. Etudes Generales; pp. 536; illustrated. Tome II. Premiere Part. Metaux: Essais mecanique; etude des essais de divers metaux et de certaines pieces assemblees; pp. 348; illustrated. Tome II. Deuxieme Parte. Materiaux autres que le Metaux; pp. 207; illustrated. Paper; 9 × 13 ins. Paris: Vve. Ch. Dunod, 49 Quai des Grands-Augustins. 1901. Three volumes, 50 francs; or, separately, 25, 18 and 12 francs.

The first volume of these reports of the International Congress on Methods of Testing Materials of Construction, held in Paris in July, 1900, is devoted to general studies of the molecular composition of bodies and their laws of deformation when stress is applied. This volume also deals with the history of testing methods and the laboratories and apparatus for testing. In all, thirteen papers are presented upon these subjects by members of the Congress, with illustrations showing the apparatus and the arrangement of testing plants. The first part of the second volume takes up the metals in relation to testing methods. Nine papers are given upon the following subjects: "Influence of Time and Temperature Upon the Mechanical Properties of Metals," Andre Le Chatelier; "Punching as a Method of Test," M. Bacle; "Torsion Tests," M. Rateau; "The Resistance of Materials as Autographically Registered by the Pendulum Machine," Robert M. Thurston; "Testing Metals by the 'Ville en Acier' Method," J. A. Brinell; "Defining Cast-Iron, Iron and Steel," Al. Pourcel; "Tests by Tempering," Georges Charpy; "Conditions and Methods of International Tests for Steel and Iron from the Point of View of an American Engineer," Wm. R. Webster; "Proposed Normal American Specifications Examined; Discussion of Commercial Methods of Physical and Chemical Tests as Now in Use in the United States, and a Critical Examination of Foreign Specifications for Steel Rails," Albert L. Colby. Papers upon nickel-steel were presented by Ch. Ed. Guillaume, H. F. J. Porter and Mr. Howe, followed by "The Staying of Locomotive Boilers," Mr. Le Blaut; "Tests of Red Copper," E. Demenge; "Experimental Studies Upon Metal Bridges," M. Lanna; "The Manufacture of Chains from Martin Steel for Suspension Bridges," Jules Seefehlner; "Methods of Testing Construction in Armed Beton," M. Considere. All of the papers are fully illustrated. The second part of Vol. II. relates to the tests of materials other than metals, as follows: "Determination of the Qualities of a Lubricating Liquid," N. Petroff; "Effect of Frost Upon Stone," J. Marva y Mayer; "The Disintegration of Brick Masonry," V. dall 'Armi and A. Forti; "Wet Method of Determining the Chemical Constituents of Hydraulic Binders," R. Feret; "Hot Water Tests of Cements," M. Deval; "The Decomposition of Cement by Sea Water," H. Le Chatelier; "The Action of Sea Water Upon Hydraulic Mortars," Gen. Schoulatchenko; "Puzzolano Mortar in Marine Construction," O. Rebuffat; "Experiences, Naval Use and Tests of Puzzolano Mortars," R. Feret; "Slag Cement," A. Brull and H. Henry; "The Fracture of Wood in Tests for Resistance," Andre Thil; "Metal Joints in Masonry, Their Resistance Compared with Joints in Poured Metal, Cement and a Mortar of Cement or Lime," H. Tavernier.

THE GRAYDON STEAM TURBINE, invented by Lieut. Graydon, of the English Navy, is spoken of by the "London Star" as being an improvement on the Parsons turbine. Instead of the 35 knots obtained by the use of the latter, Graydon figures on 50 knots speed. As described it seems chiefly to differ from the Parsons motor, in passing the steam acting upon the vanes through a spiral opening in the shaft. The first Graydon turbine engine is already built and is soon to be tested.